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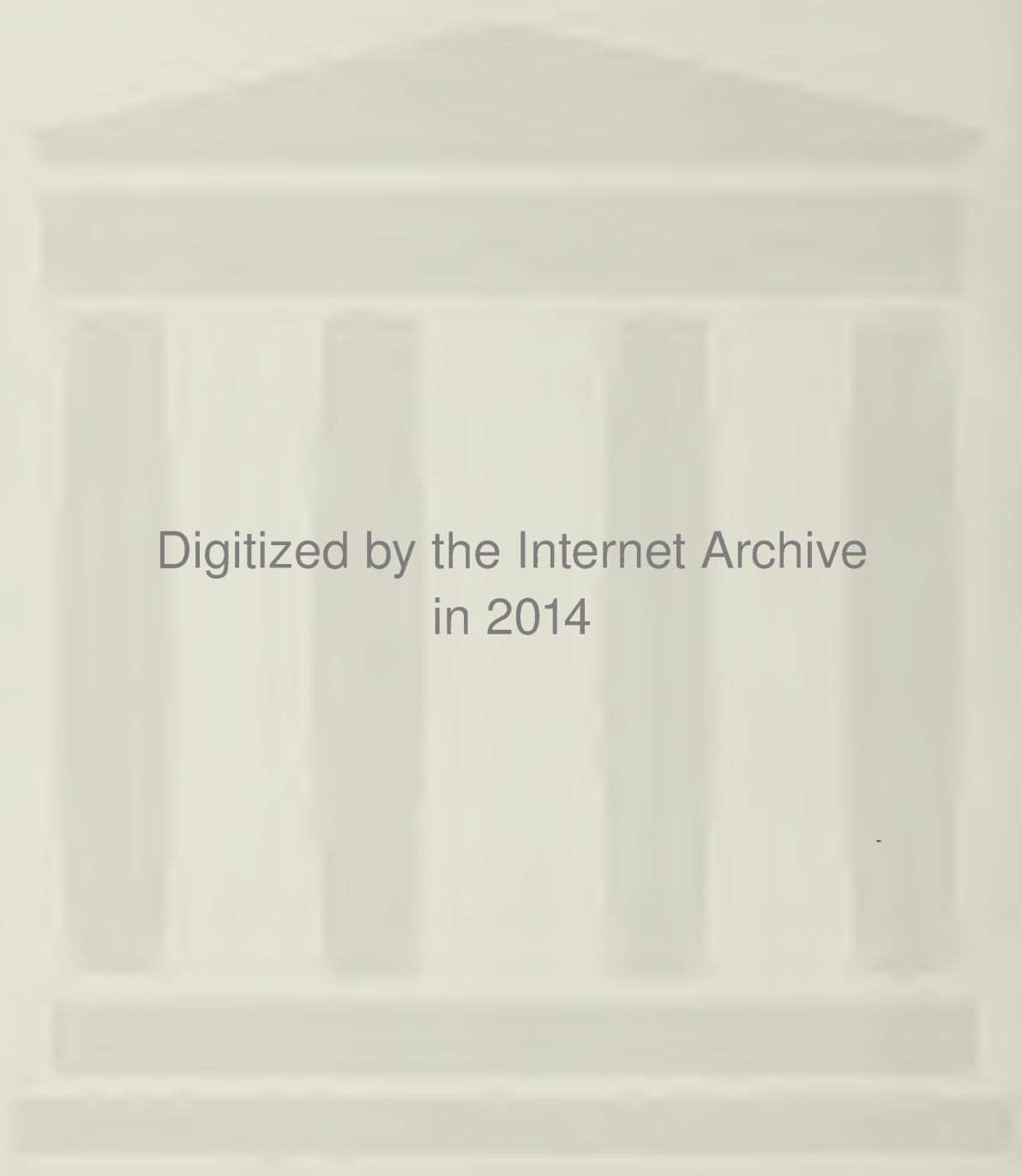
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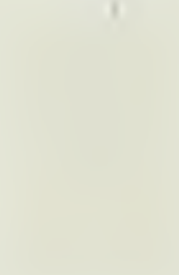
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155 Bovet Road, San Mateo, California 94402

Chlorophyll a

Chlorophyll a is the primary photosynthetic pigment in most plants and algae. It is a green pigment that absorbs light energy and converts it into chemical energy through the process of photosynthesis.



Chlorophyll a is found in the chloroplasts of plant cells, where it plays a crucial role in capturing light energy for photosynthesis.

ABSTRACT

The primary goal of this study was to identify sources of the high chlorine requirement at the Southeast Sewage Treatment Plant and determine how this requirement can be lowered while achieving satisfactory disinfection of the effluent. A survey was performed which provided information on the nature of the industrial wastes discharged to the City sewer system. A questionnaire was sent to selected industries to further define their wastes.

Samples taken from sewer mains and at various sites within the Southeast plant were analyzed for chlorine demand. Other analyses for special characteristics were also performed.

It was concluded that the primary cause of the high chlorine use and the relatively poor disinfection efficiency is a chlorination system which is unable to apportion supply in response to demand. Other causes include an unusually high rate of pre-chlorination and the presence of intermittent increases in effluent chlorine demand resulting from industrial discharges, transfers of sludge from the North Point plant, and transfers from various inplant processes.

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Section 1
INTRODUCTION

BACKGROUND

The Southeast Water Pollution Control Plant was designed about 25 years ago to treat the wastes discharged from a large residential area with a small population and a rather small commercial/industrial area. In the intervening years the inputs to the plant have changed markedly, primarily due to major increases in industrial activity, sewer modifications resulting in higher flows* and the construction of a pipeline which transports raw sludge from the City's North Point Plant (Fig. 1). During this period, an increased public awareness and concern has developed regarding the quality of San Francisco Bay waters. This concern is most directly reflected in restrictions on plant discharges imposed by the Regional Water Quality Control Board. While the City has directed considerable effort toward improving effluent quality, the Southeast plant still faces many difficulties.

The major objective of this study is to improve the chlorination system at the Southeast plant so that the required degree of sewage disinfection can be accomplished at a reasonable cost. At present, the Southeast plant uses on the order of three to five times as much chlorine (per unit of sewage treated) as the City's other treatment plants. However, the resultant disinfection remains unsatisfactory, in that samples collected near the plant's outfall in San Francisco Bay have repeatedly shown unacceptably high numbers of coliform bacteria.

* It should be noted that this study directs its attention only to sewage flow during dry weather conditions.

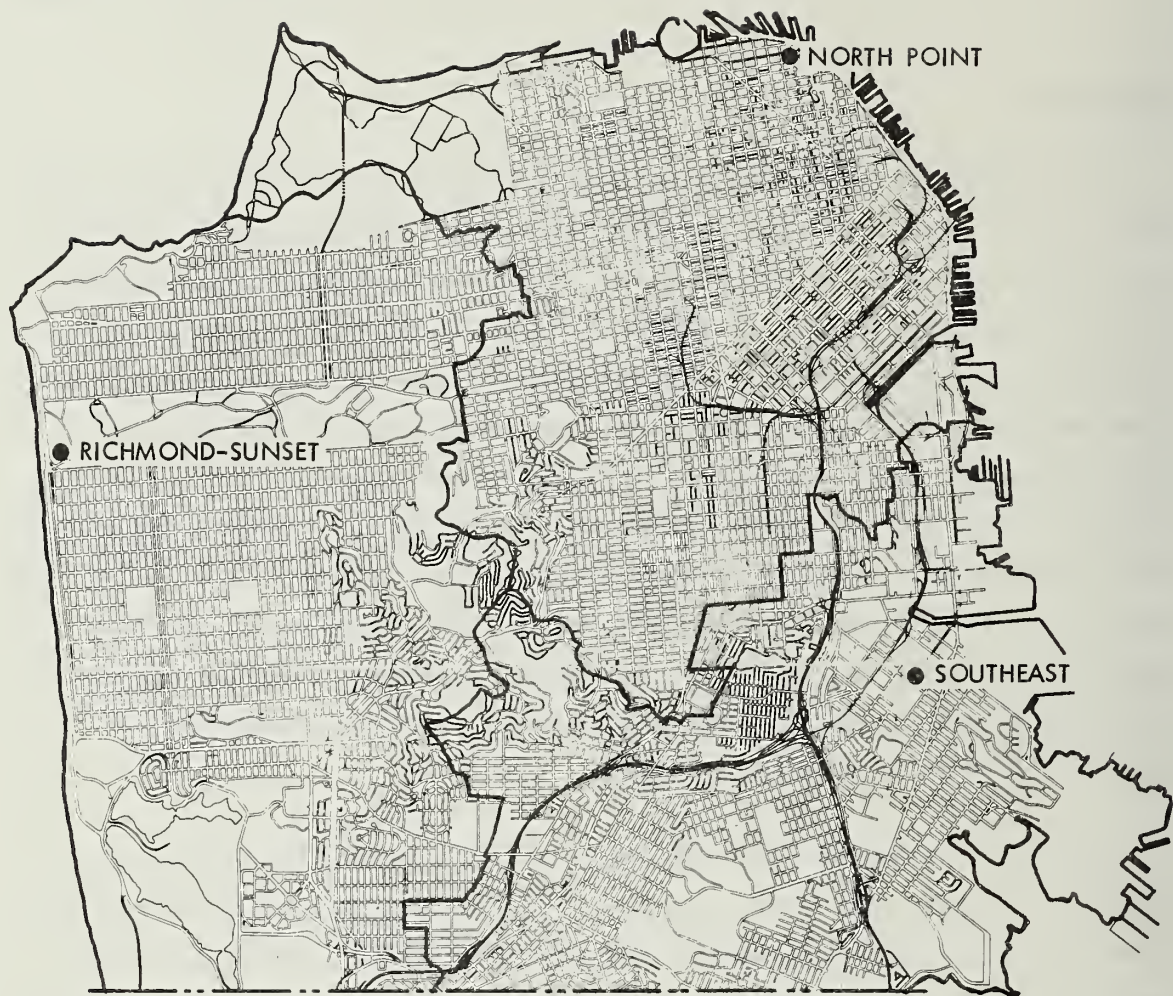


Fig. 1. Location of Sewage Treatment Plants and Tributary Areas

GOALS

The primary goals of this study are to:

- Identify the principal cause(s) of the high chlorine requirement (i.e., determine the significance of industrial wastes, North Point sludge, process or operating problems at the Southeast plant, the manner in which chlorine is applied, and other factors).
- Investigate alternative means of applying chlorine to obtain satisfactory disinfection at a reduced cost.
- Recommend actions to implement the above.

Peripheral goals which were also accomplished in this study include:

- Identification and characterization of industrial establishments in the Southeast district which contribute wastes of high chlorine demand and/or a toxic* nature to the plant.
- A review of the City's existing sewer ordinance, particularly regarding its effectiveness in controlling industrial discharges.
- Determination of the costs of chlorinating sewage at the Southeast plant.
- The design of a study to determine the extent and significance of toxic waste discharges and to investigate possible means of control.

OVERVIEW

Major tasks performed during this study are summarized in the following paragraphs. More detailed descriptions of the investigative approaches, the findings, and significant conclusions are presented in subsequent sections of this report.

Industry survey an effort which involved identifying, locating, contacting, and briefly describing the most important industrial and commercial establishments located in the tributary area of the

*The term toxic, as used in this report, refers to wastes containing significant amounts of heavy metals and/or organic pesticides.

Southeast plant. Primary emphasis was placed on identifying those establishments which appear to contribute significant amounts of wastes having either high chlorine demand and/or toxic properties. An important phase of this effort was a "drive-through" survey in which two observers in an automobile canvassed the entire industrialized area of the Southeast district to locate potential waste contributors and to assess the nature and size of these operations. Through a knowledge of those industrial and commercial activities that are likely to discharge materials of high chlorine demand and/or toxicity, the observers were able to develop a list of establishments warranting further study. Water-use records of the San Francisco Water Department were examined to identify major users. Supportive efforts included reviewing various directories, then telephoning selected firms in an effort to include only relevant entries on the list. A questionnaire soliciting information on manufacturing or processing activities and waste management practices was submitted to the most obvious waste producing establishments. Information from this industrial survey was used to guide subsequent field sampling studies and was then compiled into a reference card file. Details and results of the industrial survey are discussed in Section 2.

Field data collection an effort which involved collecting samples from selected points within the sewer system of the Southeast district and analyzing them for relevant characteristics. The purpose of the program was to determine the nature of the wastewaters delivered to the plant as well as the approximate area from which particular waste constituents originate. Samples were collected from many manholes and pump stations at various times of the day and days of the week. Sampling sites were strategically selected to permit identification of contributors by observing changes in sewage quality upstream and downstream from their point of discharge. Unfortunately, construction regulations allow establishments to make connections to the sewerage system without providing any means for direct sampling of their discharges. Samples were analyzed for chlorine demand, pesticides, and

heavy metals. Details and results of the program are discussed in Section 3.

In-plant data collection an effort which involved collecting samples from various process streams within the Southeast plant and analyzing them for selected relevant characteristics. It has long been speculated that the effect of recycling solids in the Southeast plant reduced overall plant efficiency and increased operating problems. In-plant studies were conducted to determine the extent to which this practice contributes to the high rate of chlorine use. Samples were collected from key points within the treatment process at various times throughout the day and night on both a weekday and a weekend. Samples were separated into physical fractions and then analyzed for solids, chlorine demand, and chemical oxygen demand (COD). Details and results of the program are discussed in Section 4.

Evaluation of plant operations an effort which involved analyzing data collected in the industrial survey field and plant sampling, and information obtained by direct observation and numerous discussions with City employees. The purpose of this effort was to evaluate the relative significance of factors which could conceivably be the cause of the high chlorine use rate. Details of the investigative approach are discussed in Section 5.

Review of sewer ordinance an effort which involved reviewing the City's existing sewer ordinance, which has long been ineffective in controlling industrial waste discharges, pursuant to the design of a new ordinance. The results of this review were submitted in a separate letter report to Mr. A. O. Friedland of the Division of Sanitary Engineering on April 16, 1970. They consisted of a series of recommendations concerning the amounts of specific waste constituents and characteristics to be allowed in the sewerage system.

MAJOR CONCLUSIONS AND RECOMMENDATIONS

On the basis of research reported herein, the following conclusions have been drawn:

- Chlorination, as presently practiced, does not achieve adequate disinfection with respect to Regional Water Quality Control Board requirements.
- The total amount of chlorine applied in a typical day exceeds the amount dictated by direct measurement of chlorine demand.*
- The degree of mixing of chlorine with effluent is sufficient to achieve required disinfection.
- The subsequent contact time of chlorine with effluent after mixing is also adequate.
- The cause of the poor disinfection performance is that, during brief periods, the chlorine demand of the effluent is quite high (due to slugs of strong industrial waste and/or intermittent discharges from in-plant processes). This temporarily depletes the chlorine residual required for disinfection. During these periods, very large numbers of bacteria are discharged to the receiving waters. During other periods, much of the chlorine applied is excess and is actually wasted.

It is recommended that the chlorine application system provide for continuous monitoring of effluent properties and automatically apportion chlorine in response to both chlorine demand and flow. This would reduce over-chlorination and at the same time assure adequate residuals during periods of high chlorine demand.

* While a portion of the chlorine does enter side reactions with constituents in the effluent (some are from industrial wastes, some from North Point sludge, others from recycled solids) over a typical day, the residual chlorine available should still be sufficient to achieve adequate disinfection.

Section 2

INDUSTRY SURVEY

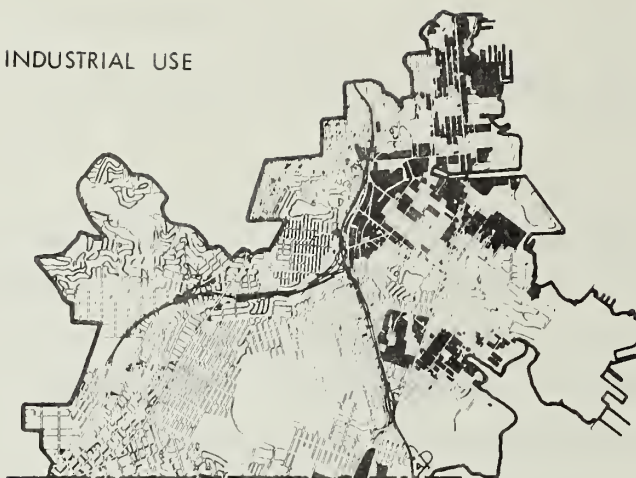
The purpose of conducting a survey of industries in the Southeast plant's tributary area was to provide a basis for estimating the quantity, character, and time variability of industrial wastes discharged to the system. As mentioned previously, the Southeast district (shown in Fig. 1) was once primarily residential, with only a few (although rather significant) industries. At present, most of the flat land has been developed by commercial and light-to-heavy industrial activities. It is generally felt that further changes in land use in the foreseeable future will be minor.

Figure 2 depicts the general patterns of residential, commercial, and industrial land use within the Southeast district. Of particular interest is the highly concentrated nature of each class of land use. The fact that most of the industry is located in two relatively definable areas greatly simplified the survey. Hunters Point Naval Shipyard is a prominent feature which is not shown on the figure as being industrialized, although it certainly is. The sewage from this installation is a mixture of residential, commercial, and industrial wastes which is conveniently collected into a single pipeline and delivered to the city for treatment. This fact also simplified characterization.

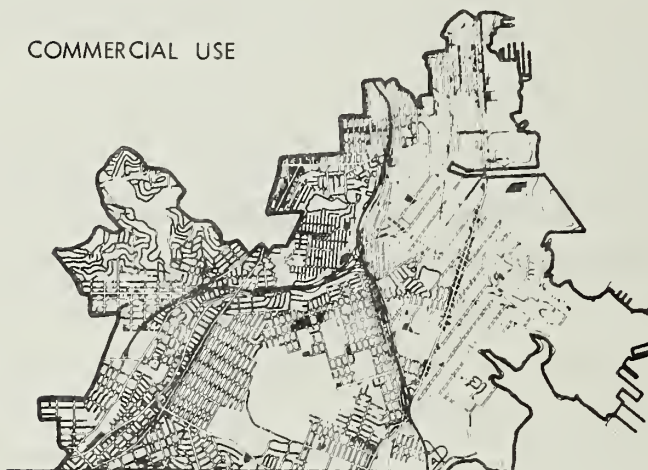
Prior to conducting the industry survey, URS staff members performed a literature review to accomplish three closely related goals:

- To increase and strengthen our understanding of chlorine chemistry and disinfection practice with particular reference to sewage and sewage effluents.
- To compile lists of materials which exert a relatively high demand for chlorine or are toxic to aquatic life in relatively low concentrations.

INDUSTRIAL USE



COMMERCIAL USE



RESIDENTIAL USE

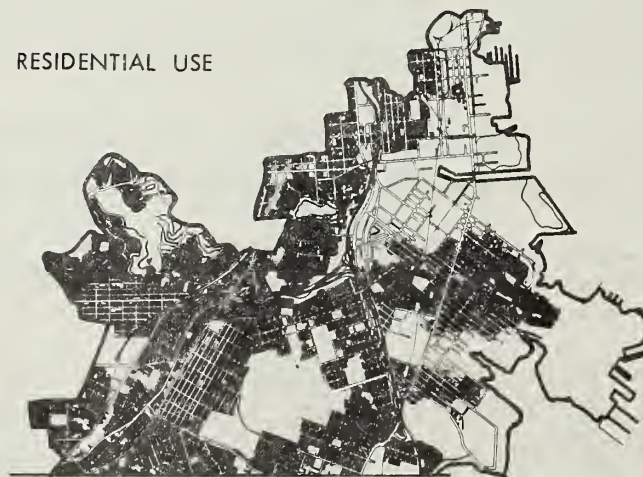


Fig. 2. Land-Use Patterns in the Southeast District

- To determine types of industries and processes which are likely to discharge wastes of high chlorine demand and/or toxicity.

Using the above described lists of potential wastes and their sources, URS staff members conducted a drive-through survey by automobile to canvass the entire industrialized area. This involved driving up and down every street and alley in the district to observe the general nature of all commercial and industrial activities. On this basis it was possible to assign virtually all establishments to one of four categories:

- 1) Probable contributor of high chlorine demand wastes
- 2) Probable contributor of toxic wastes
- 3) Possible contributor of chlorine demand and/or toxic wastes (requires further investigation)
- 4) Probably not a significant contributor of wastes.

Information obtained by the drive-through survey was then supplemented by data listed in the Directory of Manufacturers published by the Greater San Francisco Chamber of Commerce⁽¹⁾ as well as listings in the Pacific Telephone Classified Directory.

Because there is often a correlation between the pollution potential of an industry and its rate of water use, data on water consumption was collected from the records of the San Francisco Water Department. While such information cannot conclusively define an industry's likelihood of discharging pollutants, it can serve as an important index of the relative magnitude of pollution, once additional information concerning its waste discharges is available.

Telephone calls were made to screen selected establishments and assure that they were indeed engaged in the activity assumed. For example, chemical supply firms were telephoned to determine whether they handled bulk chemicals on the premises or were merely a sales office which would discharge no wastes.

At this point, all entries in categories 1, 2 and 3 were plotted on three separate maps to determine whether patterns of grouping might exist. Very little grouping was evident aside from the fact that virtually all are located east of the James Lick Freeway (about 8% are to the west but still within a few blocks of the freeway). Figure 3 is a composite map showing the location of all three categories (a more detailed map is included in Appendix C).

A questionnaire, carefully designed to obtain the following information, was submitted to more than 160 establishments.

- A description of the operations conducted on the premises
- A description of the wastes discharged to the sewer (physical and chemical properties)
- The amount of such waste discharge (gal/month)
- An indication of how these discharges vary with time (amounts as well as properties)
- A description of any in-plant waste treatment or recovery operations
- A description of any facilities which would allow sample collection and/or waste flow measurement.

A copy of the questionnaire and the explanatory material furnished with it are included in Appendix C.

It should be noted that the questionnaire does not specifically inquire about chlorine demand or toxic wastes, per se. It was purposely made general for several reasons:

- To avoid putting the industries on the defensive (it was felt that response would be more candid if the reporter were free to describe his wastes without constraint)
- To obtain information beyond that relevant to this study (for subsequent use by the City)
- To field test a questionnaire the City could also use in its Richmond-Sunset and North Point districts as needed.



Fig. 3. Location of Industries Suspected of Contributing High Chlorine Demand and/or Toxic Wastes

Company :	SIC code :
Address :	Water Dept #
Telephone :	Employees :
Contact personnel :	In house treatment facilities :
Nature of business :	Flow measurement facilities :
Relative size of operation :	Waste sampling facilities :
Water use :	
Expected wastes :	
Reported wastes - description :	
- quantity :	
-variability :	
Observed wastes - description :	
- quantity :	
- variability :	
Note : Use reverse side for recording miscellaneous information and for sketching location of sewer connections.	

Fig. 4. Sample Data Card

Industry's response to the questionnaire was relatively good, with approximately two-thirds returned (after some follow-up by telephone and by mail). The degree of detail in returned questionnaires varied markedly, from virtually no information other than a statement of having received the questionnaire, to rather detailed information concerning facilities, operations, wastes, and schedules (in some cases the completed questionnaires were supplemented by lengthy descriptions, discussions, and quantitative data). A few responses were made by telephone and by personal visits to URS offices.

The results of the completed industry survey take several forms. Perhaps the most useful is a set of data cards (one for each establishment that received a questionnaire. A sample card is shown in Fig. 4. The completeness of the data varies from card to card, reflecting the variation in response by industries. These cards are also keyed by number to the map in Appendix C showing industry locations. It is hoped that the City will be able to employ the card file provided as the basis for an ongoing industrial waste data storage system.

FIELD DATA COLLECTION

The purpose of conducting the field sampling and analysis program was to provide a quantitative data base describing the nature of wastes discharged to the Southeast plant. Over the past several years, the City staff has analyzed innumerable plant influent and field samples as part of both routine and special programs. However, these efforts were not intended to identify the geographical locales from which selected wastes originate. The field sampling program described herein was directed toward that goal.

The first step of the program involved reviewing sewer maps to identify the flow patterns that industrial discharges follow enroute to the Southeast plant. Knowing this and the location of pertinent industries, it was possible to develop a strategic sampling program consisting of 37 sites along the approximately 20 miles of major sewer mains. The majority of sites were sewer manholes, although pump stations and the plant headworks were also included (see Fig. 5). Geographical areas containing waste sources were isolated by selecting sample sites upstream and downstream from major sewer junctions. Additional sites were located upstream and downstream from industries which were suspected of being significant dischargers of high chlorine-demand and toxic wastes. Each site was sampled several different times to ensure data reliability and to detect any significant variations with time. The number of samples collected varied from site to site from a mean of 3 to 4 to a high of 34 (collected at the plant headworks).

About two-thirds of the samples were taken for chlorine demand analysis; the remainder were to identify toxic constituents. Chlorine demand was measured using a modification of the iodometric method described in Standard Methods⁽²⁾ (12th edition). The modified procedure,

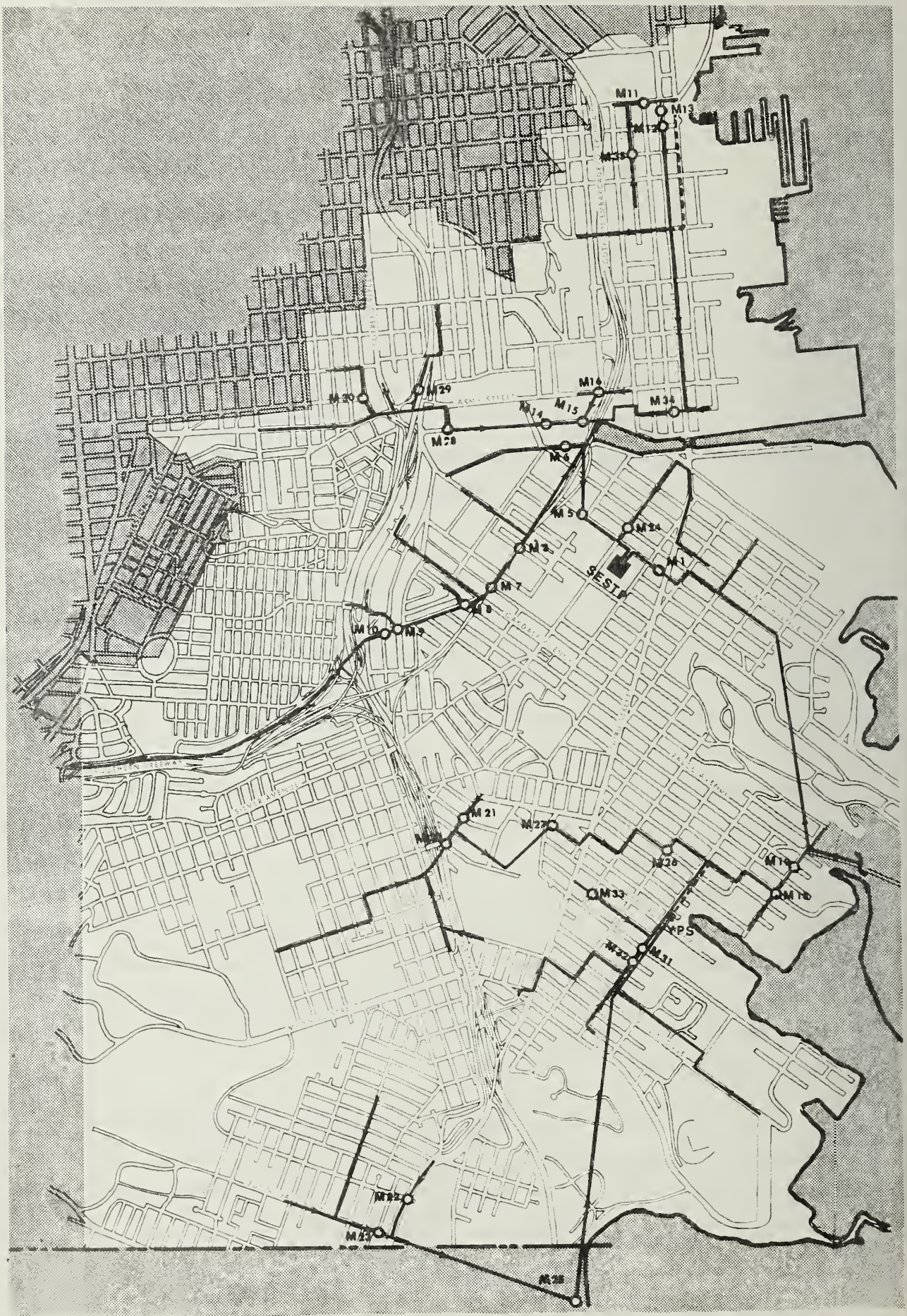


Fig. 5. Location of Field Sampling Sites and Sewer Mains

by Nusbaum and Meyerson⁽³⁾, involves the use of potassium iodate as a primary standard and as a back-titrant against an excess of thiosulfate. Because of their inherent instability, all samples were analyzed for chlorine demand within 15 minutes of collection.

Perhaps the most significant finding of the field sampling program was that industrial waste discharges are extremely erratic with respect to time. While this is to be expected in all industrial waste studies, it was found to be of particular importance to the operational difficulties at the Southeast plant. The erratic nature of sewage chlorine demand is, of course, due to the dumping of "slugs" of spent process wastes, wash water, or cooling water. It is common practice in most industries to dump unwanted materials in slugs, whether the source process is operated on a batch or a continuous basis. Such slugs can be of high or low or even negative chlorine demand (i.e., oxidizing agents); the resulting effect on the sampled stream is the same: an increase in the erratic character of the sewage.

When studying sewage properties in a system which transports mixed residential, commercial, and industrial wastes, it is imperative that sufficient sampling be performed. A danger lies in being misled by placing unwarranted emphasis on a few pieces of data. On the other hand, it is unwise to expend an inordinately large effort to collect vast amounts of data if indeed the variability of that data is so high as to preclude any practical interpretation. This field sampling program was designed so as to be intermediate between these extremes.

Sufficient data was obtained to reveal the existence of a notably high variability in chlorine demand. Attention was then directed toward determining the practical effect this variability might have on operations at the Southeast plant. It was determined that very high, short-term peaks of chlorine demand do indeed reach the plant and, for short periods of time, use up chlorine faster than it can be applied. However, after reviewing all of the data collected in the field and at the plant headworks (a total of nearly 100 separately analyzed samples), it was not

possible to identify any recurrent patterns of slugs with respect to time (i.e., the discharge of waste slugs by industry as a whole appear in a random manner). This observation was important because it revealed the futility of conducting extensive sampling in search of "predictability" in what we found to be an inherently random system. It also led to the conclusion that chlorine can be applied effectively only by continuously monitoring waste properties and not by varying chlorine feed rate on a preprogrammed schedule.*

A major element of the field sampling program was to determine the approximate geographic locale of chlorine demand and toxic waste sources by observing how sewage properties change from point to point throughout the system. Because of the aforementioned unpredictable, sharp variations in sewage composition, however, it was not possible to use field data to develop any quantitative descriptions of how sewage properties change throughout the system, although the data was of some value in locating (or confirming the location of) major contributors. For example, samples collected downstream from Legallet Tanning and Wool Companies showed a significant increase in chlorine demand, color, odor, temperature, floating matter, and heavy metals over upstream samples. However, it would be presumptuous to quantitatively attribute all such increases to Legallet since there is a small plating shop located nearby which could well account for the observed increase in chromium. The field data collected does have value in that it can provide a basis for directing further attention to both Legallet and the plating shop.

Table 1 summarizes data from the chlorine demand field sampling program.

* It should be noted that a diurnal variation in chlorine demand does exist, but that, relative to the problems of disinfection, the short-term peaks are of foremost concern.

Table 1. CHLORINE DEMAND DATA FROM FIELD SAMPLING PROGRAM

SITE	LOCATION	DAY / TIME	Cl ₂ DEMAND (mg/l)	SITE	LOCATION	DAY / TIME	Cl ₂ DEMAND (mg/l)
M-1	Galvez & 3rd	F/10:10 W/11:00 Tu/9:35 Th/9:45	74.8 21.0 112.4 36.0	M-12	3rd & 18th	Tu/10:15 F/13:30	1.5 2.9
M-3a	Selby & Kirkwood	M/9:20 F/14:30	1.4 2.4	M-13	3rd near Mariposa	Tu/10:20 F/13:25	1.4 2.9
M-3b	Selby & Kirkwood	M/9:20 F/2:35	1.5 1.5	M-14	Marin near Evans	F/11:30 M/13:45 Tu/13:40 F/14:35	6.8 10.0 3.9 2.7
M-5	Rankin & Galvez	M/13:45 W/9:30 Tu/10:45 Th/9:55	2.5 1.8 5.5 5.0	M-15	Marin near Islais Creek	F/10:50 Tu/15:10 Tu/13:45 F/14:30	4.5 21.2 3.3 3.4
M-7	Selby & Newcomb	F/16:00 W/14:00 W/10:00	2.1 1.9 1.0	M-16	Army near Pennsylvania	F/11:00 W/14:20	7.0 8.7
M-8	Industrial & Palou	M/14:05 W/10:05	3.9 3.0	M-18	Griffith & Schafter	M/14:35 Th/9:05 Th/3:05	11.5 3.2 6.7
M-9	Industrial & Charter Oak	M/10:20 Th/13:20	2.4 1.6	M-19	Griffith & Quesada	M/14:40 Th/9:10 Th/15:10	60.5 81.1 44.6
M-10	Industrial & Loomis	M/10:25 Th/13:25	3.1 1.6	M-20	Phelps & Egbert	Th/10:45 Tu/8:35 W/13:30	2.8 2.7 3.9
M-11	Mariposa & Tennessee	Tu/10:25 F/13:35	1.3 5.0				

Table 1. (Continued)

SITE	LOCATION	DAY / TIME	Cl ₂ DEMAND (mg/l)
M-21	Phelps & Carroll	Tu/8:40 W/13:20	1.3 1.5
M-22	Bayshore & Visitacion	Tu/13:15 F/9:10	22.0 10.5
M-23	Sunnydale & Desmond	Tu/13:30 F/9:15	1.7 2.2
M-24	Fairfax & Quint	F/15:00 W/9:20 Tu/10:40 Th/9:50	15.5 16.0 14.4 6.5
M-25	Bayshore Exit- Candlestick	Tu/13:00	8.4
M-26	Underwood & Jennings	Tu/14:15 Th/10:10	9.3 5.7
M-27	Yosemite & Mendell	Th/10:05	5.7
M-28	Marin & Kansas	Tu/14:40 W/10:00	4.7 11.5
M-29	San Bruno near Army	Tu/14:30 W/9:55	1.7 4.7
M-30	Hampshire &	Tu/14:35	5.2
SITE	LOCATION	DAY / TIME	Cl ₂ DEMAND (mg/l)
M-31	Ingalls & Carroll	F/11:10	4.5
M-32	Ingalls & Donner	F/11:15	3.8
YPS	Yosemite Pump Station	W/14:00 F/10:45	13.4 12.9
P-1	Plant Influent	F/10:10 W/13:30 Tu/20:55 Tu/9:40 W/9:15 Th/9:15 Su/8:20 Su/13:17 Su/15:20 Su/20:15 Su/00:30 Su/6:30 Tu/8:30 Tu/11:30 Tu/15:55 Tu/22:30 Tu/2:40 Tu/4:15	1.97* 1.73* Neg.* 60.3 124.0 39.3 33.7 33.1 6.3 2.2 2.1 96.0 24.9 12.8 9.75 3.6 4.1 5.1

In this study toxic substances were considered only briefly, the primary intention being to obtain an overview of the problem. The heavy metals selected for analysis were those known to be toxic to marine life in low concentrations and suspected as being present in Southeast sewage. These included chromium, zinc, lead, tin, copper, and cadmium. Analyses were conducted by Metallurgical Laboratories, Inc. of San Francisco on ash residues from the sewage using emission spectrography procedures. The concentrations found (listed in Table 2) vary widely from only trace amounts to many times the lethal limits for common marine organisms, (4), (5). The data clearly indicates that heavy metals are presently being discharged in significant quantities. For example, the 29.10 mg/l of chromium at site M-19 was measured in a composite sample collected from a relatively high total sewage flow. The concentration at the actual point of discharge must have been very high, considering that only 1.63 mg/l chromium was measured at M-18 only two blocks upstream. The Southeast plant is virtually incapable of removing heavy metals from solution nor is there any practical way to treat them, once they are diluted in sewage. Therefore a reduction in the amount of heavy metals discharged to the Bay can be achieved only by controlling the amount which enters the system. The City is presently developing an industrial waste ordinance which will provide a mechanism for controlling industrial toxic discharges. In order to effectively administer the ordinance, however, it will be necessary to conduct studies to detect and quantify discharges. Appendix A describes such a series of studies.

The pesticides analyzed include DDT, DDD, DDE, Dieldrin, Lindane, and Heptachlor-epoxide. Allied Life Sciences in San Leandro conducted these tests. Extractions were done with petroleum ether, followed by column chromatography with florisil and final analysis with a gas chromatograph using electron capture. As in the case with heavy metals, a series of sampling points were selected on the basis of information obtained in the industry survey. Field data are summarized in Table 3.

Table 2. HEAVY METALS DATA FROM FIELD SAMPLING PROGRAM

SITE	LOCATION	DATE / TIME	CHROMIUM (mg/l)	ZINC (mg/l)	LEAD (mg/l)	TIN (mg/l)	COPPER (mg/l)	CADMIUM (mg/l)
M-1	Galvez & 3rd	8-26/10:55 8-28/13:25 9-2/14:50	4.57	1.15	0.26	0.06	0.33	0.002
M-7	Selby & Newcomb	8-26/9:55 8-28/16:05 9-2/15:00	0.50	0.70	0.12	0.50	0.15	0.0008
M-15	Marin near Islais Creek	8-26/10:05 8-28/15:50 9-2/15:25	0.64	4.82	0.66	0.05	0.26	0.0004
M-18	Griffith & Schafter	8-26/11:10 8-28/14:45 9-2/14:15	1.63	2.05	0.63	0.01	0.32	0.001
M-19	Griffith & Quesada	8-26/11:15 8-28/14:40 9-2/14:10	29.10	0.88	0.23	0.06	0.38	0.002
M-25	Bayshore Exit- Candlestick	8-26/11:25 8-28/15:10 9-2/14:25	2.97	3.62	0.12	0.20	0.43	0.001
M-27	Yosemite & Mendell	8-26/11:50 8-28/15:05 9-2/14:40	1.36	0.42	0.07	0.02	0.14	Nil
M-28	Marin & Kansas	8-26/10:10 8-28/16:00 9-2/15:05	0.13	0.30	0.24	0.01	0.15	Nil
M-33	Keith & Bancroft	8-26/11:45 8-28/14:55 9-2/14:35	0.22	1.72	0.10	0.01	0.10	0.0006
M-34	3rd & Marin	8-26/10:30 8-28/15:45 9-2/15:20	0.36	1.38	0.16	0.01	0.11	0.003
M-35	Minnesota & 19th	8-26/10:50 8-28/15:35 9-2/15:10	0.16	11.20	0.12	0.02	0.05	0.0004
SFNS	Hunters Point Naval Shipyard	8-28/14:25 9-2/14:05	0.14	0.20	0.01	0.01	0.04	0.003

Table 3. PESTICIDE DATA FROM THE FIELD SAMPLING PROGRAM

SITE	LOCATION	DATE / TIME	DDE (ppb)	DDT (ppb)	DDD (ppb)	Dieldrin (ppb)	Lindane (ppb)	Heptachlor- epoxide (ppb)
M-1	Galvez & 3rd	8-26/10:55 8-28/15:25 9-2/14:50	0.24	0.10	0.12	0.08	0.10	<0.01
M-7	Selby & Newcomb	8-26/9:55 8-28/16:05 9-2/15:00	0.67	0.22	0.19	0.15	0.09	<0.01
M-18	Griffith & Schafter	8-26/11:10 8-28/14:45 9-2/14:15	0.39	0.12	0.11	0.08	0.11	0.01
M-25	Bayshore Exit- Candlestick	8-26/11:25 8-28/15:10 9-2/14:25	0.12	0.25	0.06	0.12	0.11	<0.01
M-27	Yosemite & Mendell	8-26/11:50 8-28/15:05 9-2/14:40	0.23	0.23	0.22	0.11	0.14	0.02
SFNS	Hunters Point Naval Shipyard	8-28/14:25 9-2/14:05	<0.05	0.26	0.11	0.16	0.12	0.02

The Southeast plant has virtually no ability to remove dissolved pesticides. Therefore, reducing pesticide loading on the Bay can again be achieved only by means of source control. The studies described in Appendix A would provide a method for controlling discharges at the source.

IN-PLANT DATA COLLECTION

An in-plant sampling and analysis program was conducted with a dual purpose: to establish an understanding of plant performance, and to provide a basis for predicting the consequences of altering various operating procedures. Both purposes were directed toward the goal of achieving improved disinfection and, at the same time, reducing the amount of chlorine used. Figure 6 is a diagram of the operative mode commonly employed at the Southeast plant. It was developed as the result of discussions with City engineering and operating staffs.

The plant is capable of operation in a number of different process modes by merely adjusting valve positions and pumping rates. During the study, it was noted that this variable capability is exercised frequently. In the course of the study, URS staff observed apparent disagreement within the City engineering and operating staff as to the best method(s) of operating the Southeast plant. This situation accounts for variation noted in plant performance. This is mentioned here because it is pertinent to certain subsequent comments regarding the reliability of data collected in the plant.

It should be noted that Fig. 6 is actually a schematic diagram, in that many subtleties of the sub-processes (i.e., interconnections and inputs of water, air, chemicals, etc.) are omitted for simplicity. The primary focus of the in-plant study was chlorine demand and application. It was from this frame of reference that in-plant sampling points were selected.

It has been suspected by City staff that certain aspects of the operations at the Southeast plant are responsible for the high chlorine use. North Point sludge (which is transferred across town via a force main) and the supernatants returned from the sludge elutriation and

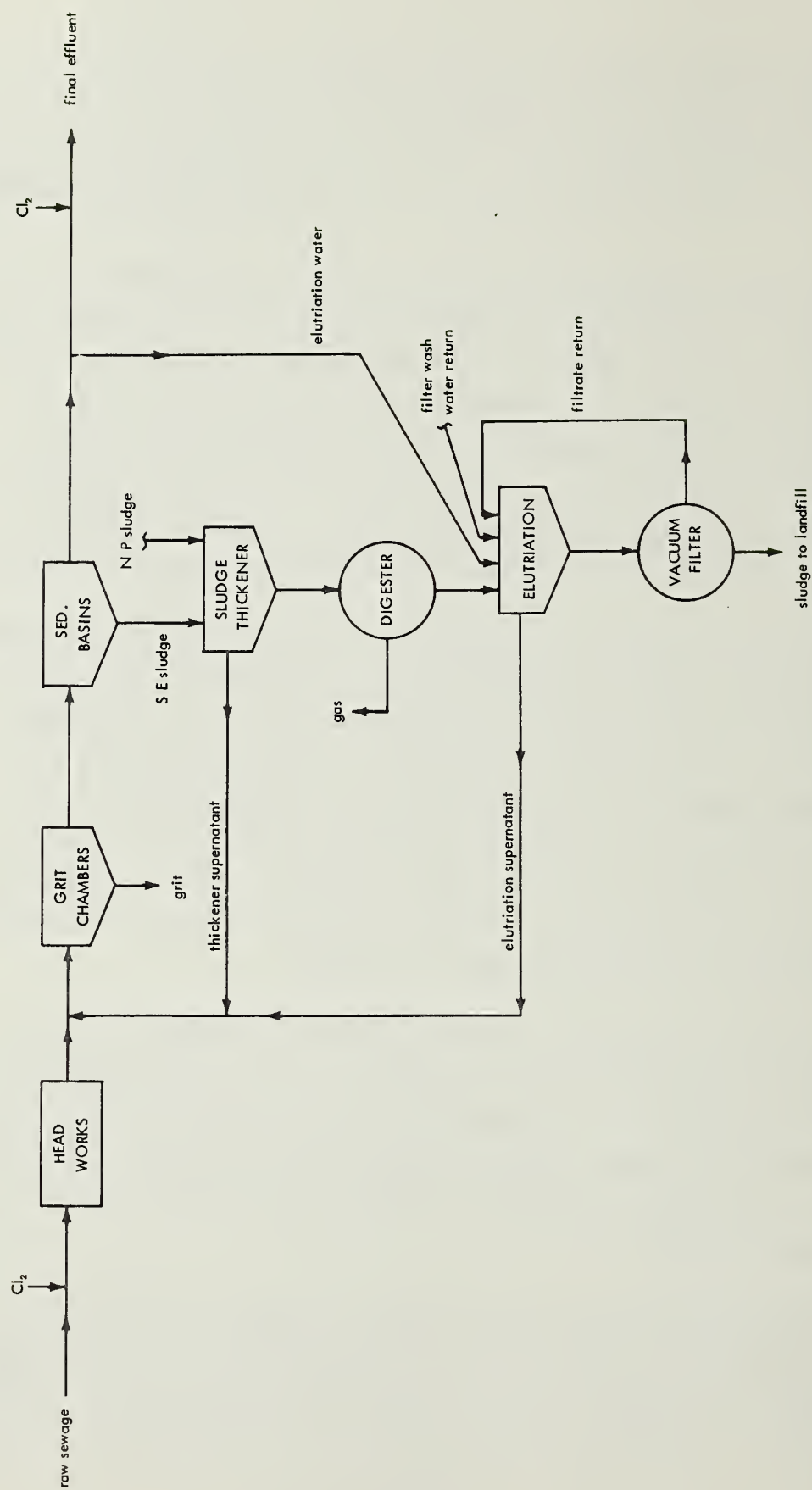


Fig. 6. Schematic Flow Diagram of Southeast Sewage Treatment Plant

thickening processes are believed to be prime causes. These and other pertinent flows were subjected to around-the-clock sampling on two different days (a Sunday and the following Tuesday). Chlorine-demand tests were run on all samples within a few minutes of their collection. The results of these all-day tests are given in Table 4. A diurnal change in chlorine demand is evident only in the plant influent and effluent (P-1 and P-2 respectively). This would be expected since the detention time and degree of mixing in all other process units are far too extensive to reflect any short-term changes in chlorine demand in response to influent variations. This is not to say that samples collected from the sites are uniform with respect to time; they are not, as the data shows. However, these variations are caused more by irregularities in each process' input or operating conditions than to diurnal changes in plant influent.

At the outset of the study, it was planned that chlorine demand (as determined by a 10 minute contact time with a saturated aqueous solution of chlorine gas) would be used to measure a sample's ability to consume chlorine. The shortcoming of this approach is that additional chlorine continues to be consumed beyond the arbitrary 10 minute contact period. The relationship between the amounts consumed before and after the 10 minute period depends upon the nature of the waste constituents (primarily their reaction rates and their physical state). Since the constituents are unknown and are certainly not distributed uniformly among all plant streams, it was decided to supplement chlorine demands with chemical oxygen demands (COD).

The COD test is capable of measuring many organic substances which would escape detection by the 10 minute chlorine-demand test. This is due primarily to differences in reaction conditions; (i.e., the COD test uses a high concentration of strong oxidizing agent at low pH in the presence of a catalyst with good mixing, and high temperature for an extended time period). The reaction conditions of the chlorine-demand test are mild in comparison, so that only the most readily oxidizable materials become involved.

Table 4. CHLORINE DEMAND RESULTS FROM 24-HOUR SAMPLING PROGRAMS

SITE	LOCATION	DAY / TIME	Cl ₂ DEMAND (mg/l)
P-1	Plant Influent	Su/8:20	33.7
		Su/13:17	33.1
		Su/15:20	6.3
		Su/20:15	2.2
		M/00:30	2.1
		M/6:30	96
P-2	Plant Effluent	Tu/8:30	24.9
		Tu/11:30	12.8
		Tu/15:55	9.8
		Tu/20:55	Neg.*
		Tu/22:30	3.6
		W/2:40	4.1
		W/4:15	5.1
		Su/9:45	34.0
		Su/13:20	18.2
		Su/15:45	12.2
P-3	North Point Sludge at SE Plant	Su/21:35	7.5
		M/1:30	6.4
		M/5:45	6.8
		Su/8:30	51.2
		Tu/14:15	6.1
		Tu/16:20	24.4
		W/2:00	10.8
		W/4:15	10.2
		W/6:15	10.6
		Su/10:00	91.2
P-2 (cont.)		Su/11:30	111.5
		Su/14:10	85.8
		Su/17:00	122.3
		Su/23:30	186.0
		Tu/10:20	7.1
		Tu/12:30	138.5
		Tu/17:30	105.8
		Tu/21:00	98.0
		W/00:05	76.0
		W/2:45	91.0
		W/5:30	81.7

Table 4. (Continued)

SITE	LOCATION	DAY / TIME	Cl ₂ DEMAND (mg/l)
P-4	Thickner Supernatant	Su/10:52	55.0
		Su/14:15	253.5
		Su/17:05	74.5
		Su/21:00	105.6
		M/4:30	132.5
		M/6:30	180.0
		Tu/10:25	114.2
		Tu/15:15	196.8
		Tu/17:55	191.9
		Tu/21:00	148.5
P-5	Filtrate	W/00:05	106.8
		W/2:45	114.3
		W/6:15	126.3
		W/3:00	534.3

SITE	LOCATION	DAY / TIME	Cl ₂ DEMAND (mg/l)
P-6	Elutriation Supernatant	Su/10:55	356.0
		Su/15:00	327.0
		Su/18:45	281.0
		Su/23:55	44.0
		M/3:45	551.0
		Tu/11:30	147.4
		Tu/15:45	91.5
		Tu/20:55	30.0
		Tu/23:40	73.7
P-7	North Point Sludge at North Point	W/1:15	76.0
		W/3:45	72.0
		Su/8:30	12.1
		Su/12:30	27.1
		Su/16:30	72.3
		Su/20:30	22.0
		M/4:30	47.8
		Tu/8:30	27.4
		Tu/12:30	39.3
P-7	North Point Sludge at North Point	Tu/16:30	75.3
		Tu/20:30	148.7
		W/00:30	15.2
		W/4:30	27.9

In dealing with a mixture of residential, commercial, and industrial wastes, it is not possible to know, with any degree of confidence, the substances which comprise any given sample. The industry survey, however, led URS staff to suspect that substances could well be present in the sewage which, because of either their physical or chemical nature, would not show up in a chlorine-demand test but would, after sufficient detention time in the plant, decompose to a state which would exert a chlorine demand. This concept can best be described by an example. Consider a discrete organic waste particle. If the entire particle is included in a waste sample, it would probably not demand very much chlorine during the 10 minute contact time. However, if the particle is finely ground, quite a significant amount of chlorine would be used to oxidize the fine organic solids. Carrying the thought further, if these fine solids are allowed to partially decompose (and some go into solution) before the chlorine was added, the amount of chlorine demanded in 10 minutes would be even higher (primarily because some of the organic matter would be in the soluble rather than solid state). This example demonstrates the effect of the physical character of waste constituents on chlorine demand. The chemical character is also extremely important, a point which needs no explanation other than to say that as organic solids decompose with storage their chemical character must also be expected to alter.

The above discussion relates to problems at the Southeast plant in that organic solids are indeed stored for extended periods and allowed to decompose both physically (into finer solids) and chemically (by biological activity into soluble material).

Conditions in the chlorine-demand test are such that most of the chlorine is used by material in the soluble state; virtually all of the remainder reacts with material in the colloidal state. To understand existing plant process performance and to predict the consequences of alternative processing techniques were objectives of this study. To

accomplish these, it is necessary to identify the distribution of oxidizable material in the various physical phases of any given process stream and to determine the effect that aging of organic materials has on chlorine demand. Such a study is described below.

Samples collected within the Southeast plant (P-2 through P-9) were separated into two fractions by means of settling, centrifuging, plain filtering, and Millipore filtering. The amount of solid material in each fraction was measured volumetrically and gravimetrically. In addition, the COD of each fraction was measured. Figure 7 illustrates how the samples were fractionated and analyzed. Table 5 shows the results of these analyses for all in-plant sampling sites except plant influent.

Plant influent was of primary concern in this study. The concept discussed previously (which concerns the change in measurable chlorine demand as wastes decompose) was investigated by repeatedly testing fractions of influent after progressively longer storage periods. Figure 8 illustrates the sequence of analyses performed and the resultant data.

At the outset of this investigation, URS staff hypothesized that the chlorine demand of a waste sample could conceivably increase or decrease with age, depending upon the materials which cause the chlorine demand and their relative amounts in each phase. Such chlorine-demanding compounds as sulfides and thiosulfates, being inorganic and readily oxidizable, decrease rather rapidly with time due to their reaction with air. Organic solids, on the other hand, exhibit an increase in chlorine demand due to decomposition. The purpose of fractionating plant influent, as depicted in Figure 8, was to identify the dominant phenomenon.

Figure 9 shows the result of aging on influent chlorine demand. All three fractions of plant influent show surprisingly similar decay rates, considering the outward differences between fractions (their

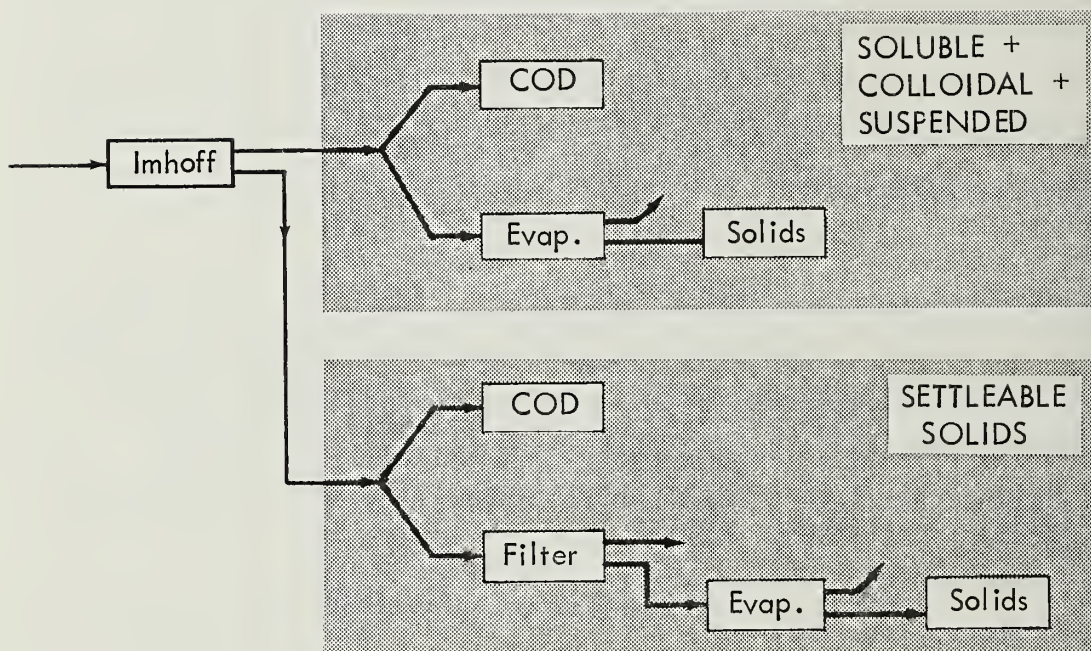


Fig. 7. Separation and Analysis Scheme for Samples P-2 Through P-9

Table 5. RESULTS OF FRACTIONATION ANALYSES FROM IN-PLANT SAMPLING SITES

SITE	LOCATION	SOLUBLE + COLLOIDAL + SUSPENDED FRACTION			SETTLEABLE FRACTION			FLOATABLE FRACTION	
		COD (mg/l)	DRY SOLIDS (g/l)	VOLUME (ml/l)	COD (mg/l)	DRY SOLIDS (g/l)	VOLUME (ml/l)	FRACTION VOLUME	(ml/l)
P-2	Plant Effluent	552	3.36	1000	-	-	Trace	0	
P-3	North Point Sludge at SE Plant	1700	2.56	880	9077	5.59	100	20	
P-4	Thickner Supernatant	1613	4.69	1000	-	-	Trace	0	
P-5	Filtrate	570	6.76	610	11,322	27.85	390	0	
P-6	Elutriation Supernatant	3995	23.3	860	3970	2.84	120	20	
P-8	Combined Supernatant Return Line	1747	27.8	820	6730	3.55	130	50	
P-9	SE Sludge	216	1.01	25	68,280	35.4	975	0	

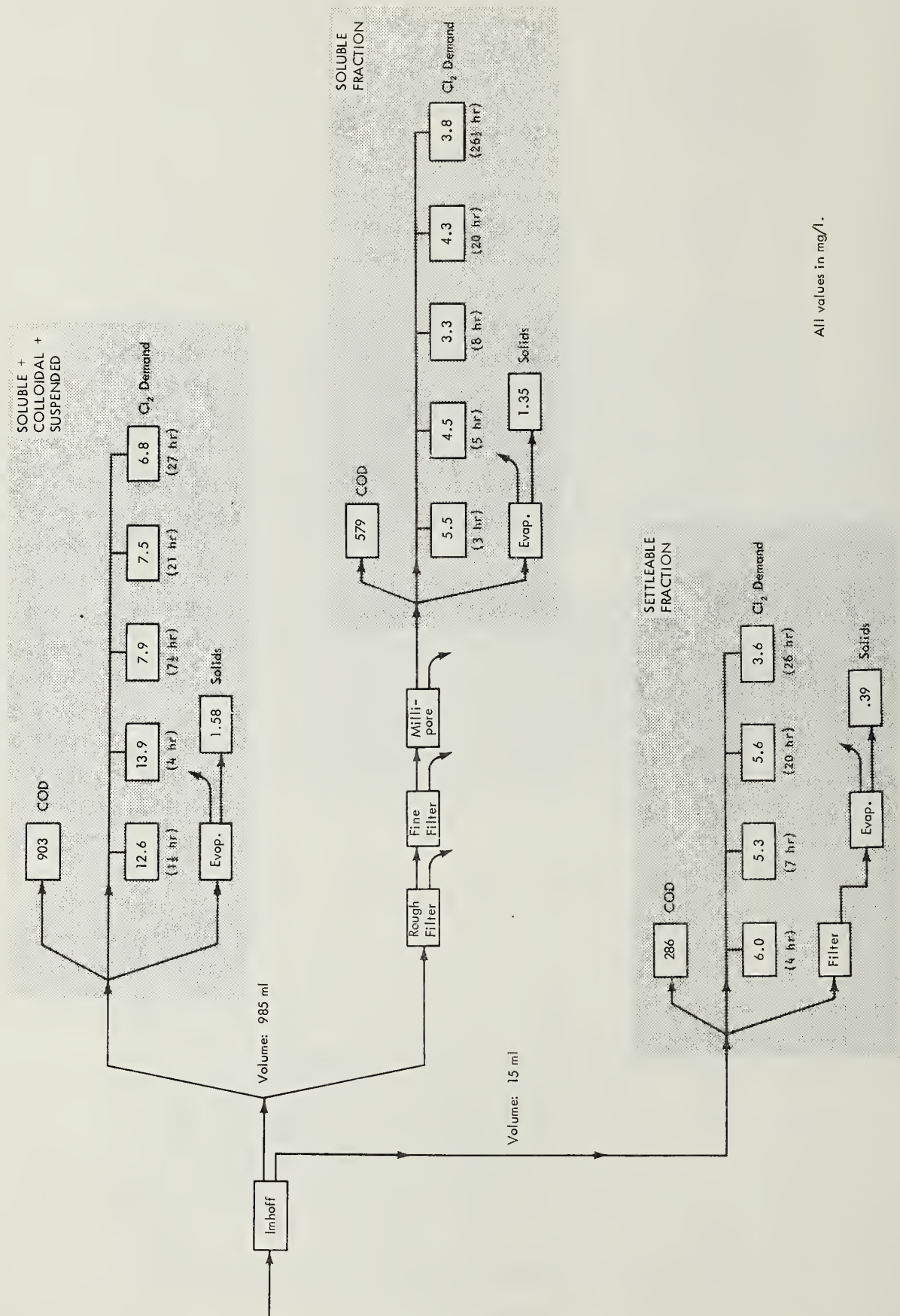


Fig. 8. Separation and Analysis Scheme for Plant Influent (P-1)

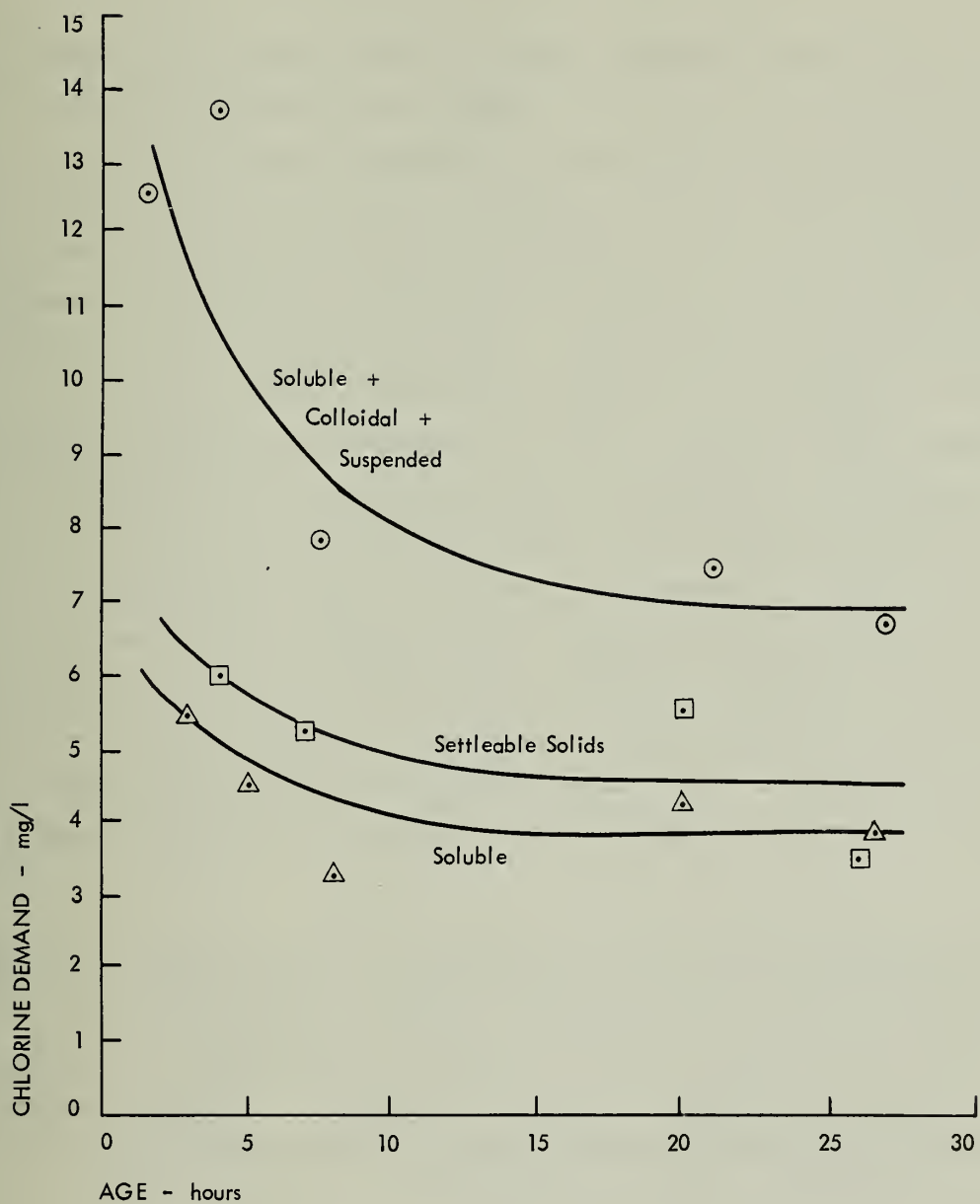


Fig. 9. Result of Aging on Chlorine Demand

amounts of total solids differed markedly). This implies that even large quantities of very fine solids do not enter into reaction during the chlorine-demand test. An alternative interpretation would be that solids behave in exactly the same manner as the surrounding soluble matter and, therefore, have no detectable effect on the overall data. In either case, the test confirmed the hypothesis that chlorine demands of all fractions decrease with time. The presumed mechanism for such decrease is air oxidation of soluble constituents. The practical significance of this finding is that it disproves the hypothesis that solids, suspended in the sewage entering in the plant, will escape measurement in a chlorine-demand analysis and then change so as to later exert a high requirement for chlorine.* This simply does not seem to be a significant phenomenon. This conclusion should not be interpreted as a statement that such a phenomenon does not or cannot occur, because with certain types of industrial wastes, it most certainly would; it just is not dominant within the aging period used here and does not seem to enter the cause/effect relationship at the plant.

An interesting and unexpected finding was the high degree of correlation between COD and chlorine demand in plant influent (P-1), as shown in Figure 10. The data are for samples representing all of the various fractions described in the above paragraphs. Data for numerous other fractions of other plant streams analyzed for both COD and chlorine demand show a similar correlation.

* That is, the concept discussed previously, using a particle of organic solids as an example, does not seem to be a dominant factor.

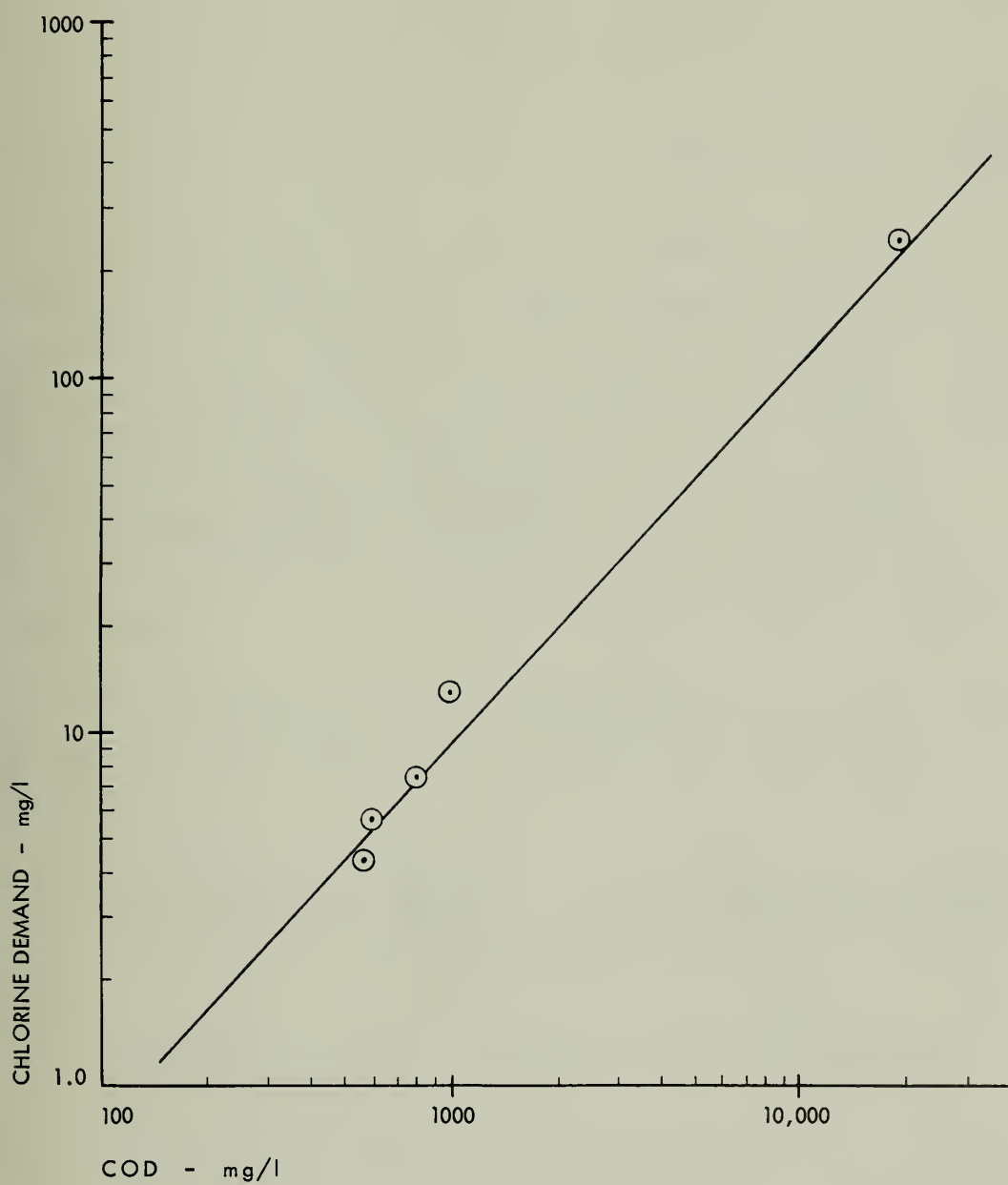


Fig. 10. Correlation Between Chlorine Demand and COD in Plant Influent (P-1)

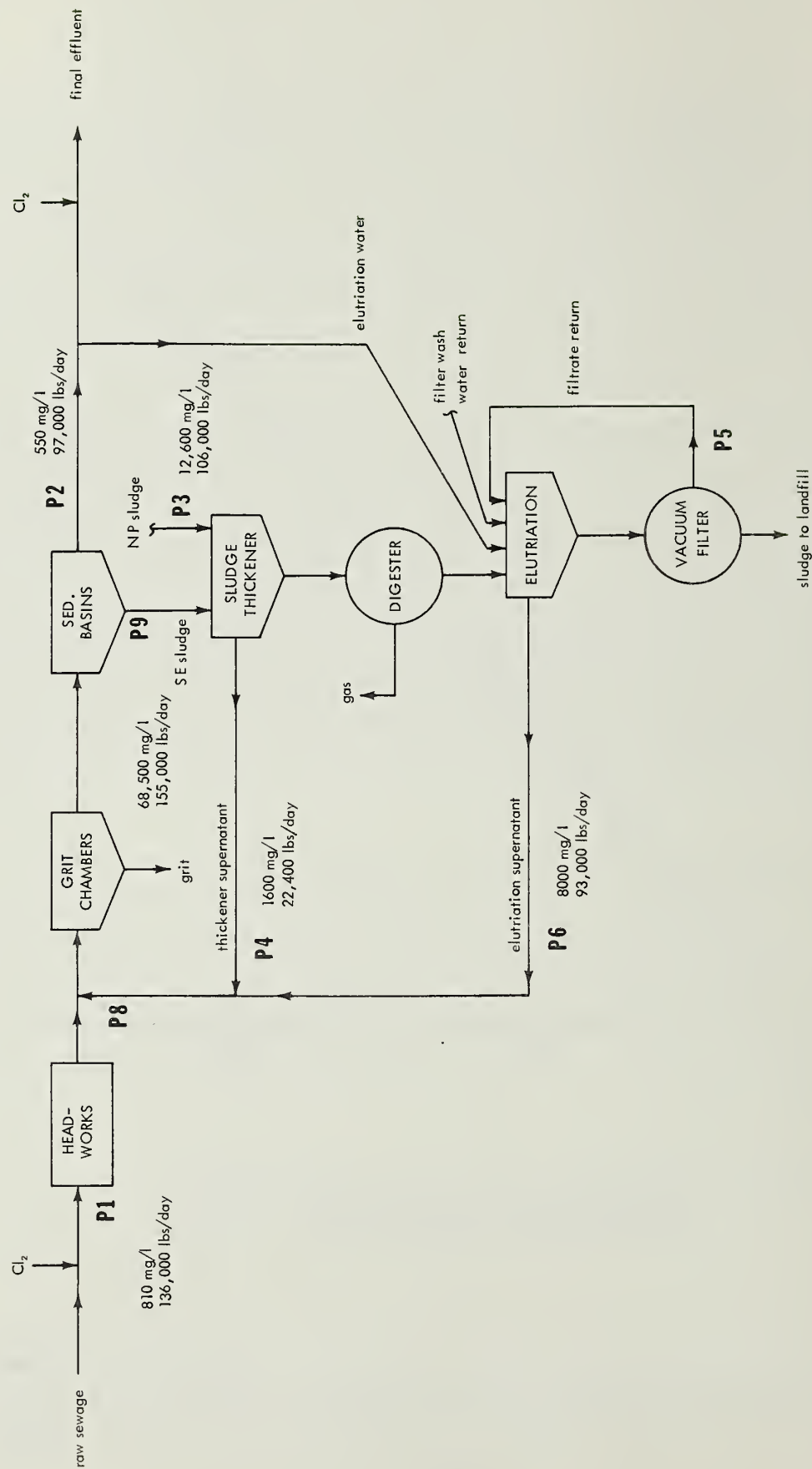


Fig. 11. Results of COD Analyses on In-Plant Samples

EVALUATION OF OPERATIONS

The overall goal of this study, as expressed earlier, was to identify the principal cause(s) of the high chlorine use at the Southeast plant. Causes suspected from the outset included industrial wastes, North Point sludge, in-plant operating problems, and improper chlorine application practices. The preceding sections described programs for collecting information. This section describes how the information was employed to derive conclusions and recommendations.

THE APPROACH

The investigative approach is explained below by stating a series of hypotheses, then discussing the reasoning used either to refute or confirm each.

- Hypothesis - Industries in the Southeast district discharge large amounts of organic and inorganic wastes which react with chlorine applied for disinfection, thereby creating the need for a high chlorination rate.

Discussion - This was found to be true. However, the mean chlorine demand at the headworks was not high enough to account for the amount of chlorine the Southeast plant used. The influent chlorine demand had a mean of about 30 mg/l; the effluent, a mean of about 17 mg/l. The actual use of chlorine is about 12,500 lbs/day which averages about 80 mg/l in a days flow. Therefore, the sewage alone cannot account for all of the chlorine used.

- Hypothesis - The chlorine-demand test does not account for the waste's total ability to tie up chlorine. The indicated chlorine demand of the sewage is below the application rate, but the real chlorine demand is as high as the application rate.

Discussion - While it is true that some oxidizable material does escape detection by the chlorine demand test, the amount

is not significant. Virtually all of the materials which enter into reactions with chlorine in the plant are accounted for in the test. Therefore, the inherent limitations of the test are not the cause of the discrepancy between measured demand and actual use. That is, very little of the 50 mg/l difference between the influent demand (30 mg/l average) and the use rate (80 mg/l average) can be attributed to difficulties in testing.

- Hypothesis - Sludge transferred from the North Point plant is the cause of high chlorination rate.

Discussion - The chlorine demand of raw North Point sludge averages about 110 mg/l for a total of about 925 lbs/day. The total chlorine demand of the effluent is over 3000 lbs/day. Therefore, even if all of the chlorine demand of the North Point sludge were to end up in the final effluent (obviously only a fraction really can), its impact would account for less than one-third of the total demand. These relationships are shown on Fig. 12.

- Hypothesis - The successive recycling of solids caused by the sludge thickening and elutriation processes allows organic materials to decompose, thereby causing increased chlorine demand and the need for a high chlorination rate.

Discussion - Special tests to investigate the effects of aging settleable, soluble, and suspended plus colloidal plus soluble fractions indicate that net chlorine demands decrease with time, rather than increase (Fig. 9). Some waste constituents could conceivably exhibit an increase in chlorine demand with aging as solids decompose, but this effect was not significant enough to be detected.

At this point in the investigation, it was concluded that the high chlorine use was not due to either strong inputs (sewage or sludge) or the decomposition of solids recycled within the plant. Attention was then directed toward chlorination practices.

- Hypothesis - Inadequate mixing of chlorine water with effluent causes much of the chlorine applied to be wasted (i.e., poor mixing yields poor disinfection).

Discussion - A review of design drawings supplemented with a field inspection of all facilities indicated that mixing is adequate. Directly upstream from the chlorine diffuser are a side channel weir and a 45° turn in the

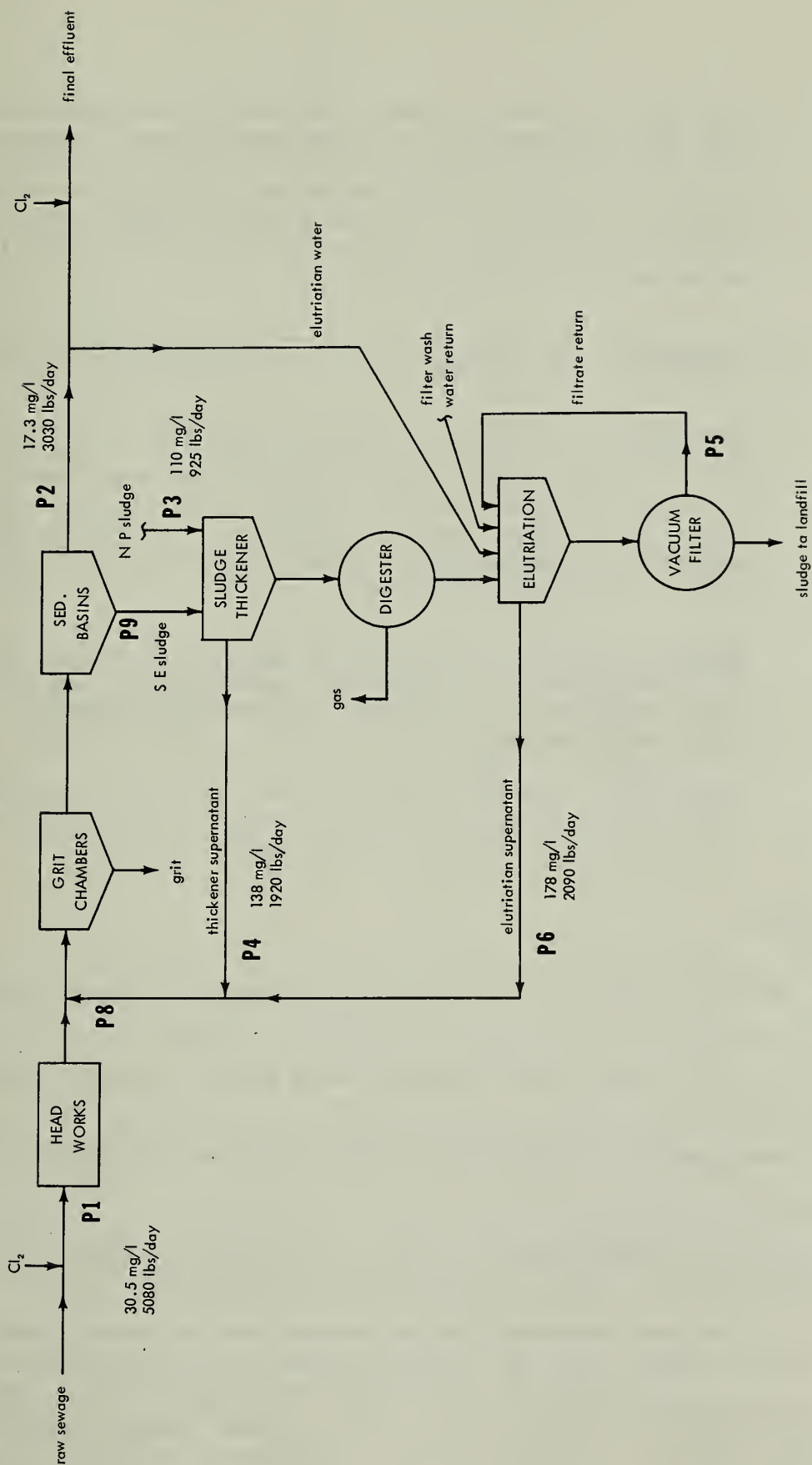


Fig. 12. Results of Chlorine Demand Analyses on In-Plant Samples

rectangular effluent channel, both resulting in turbulent flow past the submerged, multi-ported diffuser. Downstream there is increased mixing caused by a second 45° turn and five 90° turns followed by approximately 2500 ft of turbulent flow enroute to the Southeast pump station.* The pumps, appurtenances, and subsequent flow in the outfall system provide further mixing.

- Hypothesis - The contact time of chlorine water and plant effluent is insufficient to achieve adequate disinfection.

Discussion - The detention time in the conduit between the chlorine diffuser and the pump station is on the order of 30 minutes; between the pump station and the point of discharge in the Bay being an additional 45 minutes. This is far more contact time than necessary, particularly considering the high chlorine concentrations** and the high degree of turbulence throughout.

- Hypothesis - The rate of chlorine application exceeds the requirement most of the time but occasionally is not adequate, during which time sewage is discharged without proper disinfection.

Discussion - This hypothesis was found to be the principal cause of high chlorine use and is discussed in detail in the following paragraphs of this section.

FINDINGS

The Southeast plant's high cost of chlorination is due primarily to the application of chlorine at a nearly uniform rate which is significantly greater than the mean demand rate. The situation is best described graphically. Figure 13 is a hypothetical (but probably quite typical) plot of effluent chlorine requirement*** during a 24-hour day.

* It should be noted that the City's engineering and plant staffs cooperatively conducted extensive tests which demonstrated that mixing downstream from the diffuser is effective.

** The concentration of chlorine at the pump station is high enough to cause a distinct odor of chlorine outside the building most of the time.

*** "Chlorine requirement," as used here, is the sum of the chlorine demand (i.e., the amount of chlorine needed to oxidize sewage constituents to the point where any further addition of chlorine would result in a residual) and that amount of chlorine needed to achieve a residual high enough to achieve adequate disinfection (i.e., approximately 0.5 to 2 mg/l residual).

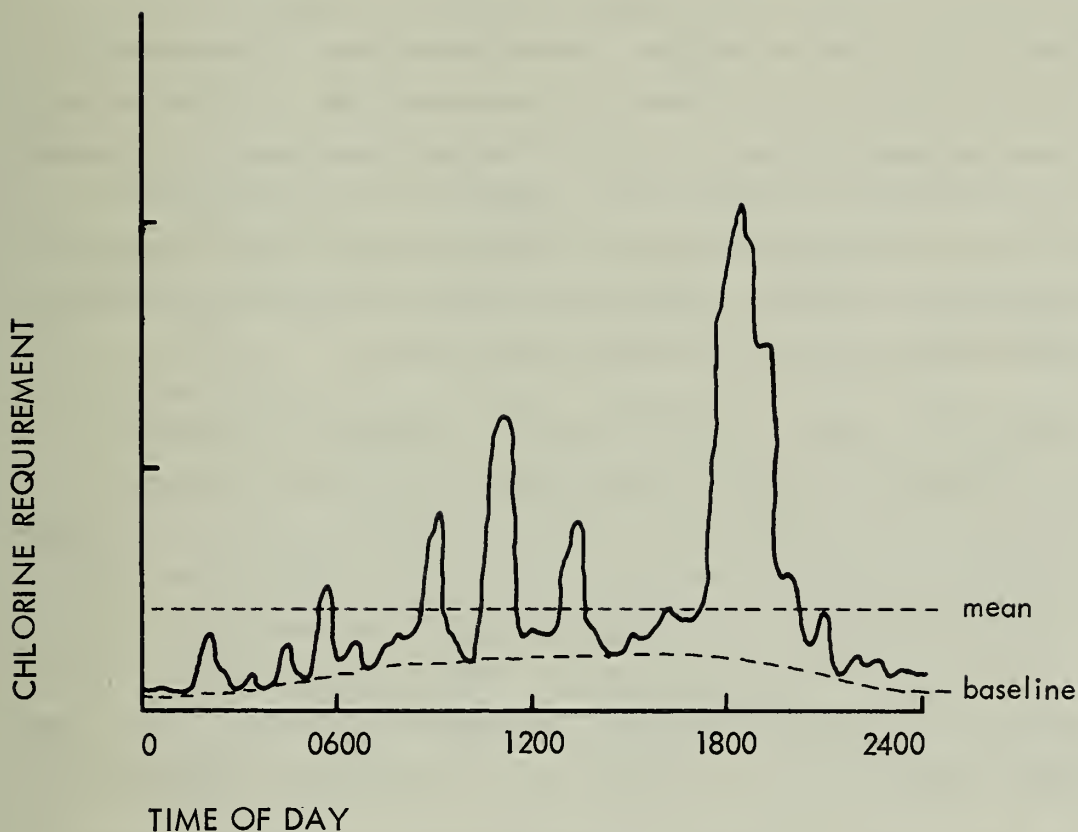


Fig. 13. Hypothetical Plot of Effluent Chlorine Requirement Over a 24-hour Period

Two important features of the plot (Fig. 13) are:

- The presence of numerous peaks resulting from slug discharges of industrial wastes, intermittent transfers of process streams within the plant, and/or the inconsistent performance of processes. All three causes of such peaks are random with respect to magnitude, duration, and time of occurrence.
- The presence of a relatively stable "baseline" which exhibits a regular diurnal variation in chlorine requirement. The peaks are superimposed on this baseline.

The relatively uniform baseline chlorine requirement curve has been the basis for prescribing routine chlorination practices. Plant personnel have recognized the regular diurnal variations in this baseline and, until recently, have been manually increasing the chlorine application rate during the times of anticipated high requirement. This was done on the basis of experience rather than the use of current data obtained from any ongoing analysis of chlorine demand and/or residual. This practice was reasonably effective in reducing chlorine costs and did provide adequate disinfection most of the time.

Recently the system has been modified to provide for automatic changes in chlorine application rate in response to flow. However, the system is still not capable of changing application rate in response to the effluents' chemical character. Experience to date is not sufficient to judge whether the flow-proportioning system has actually improved disinfection effectiveness and/or reduced chlorine costs. However, significant improvements cannot be expected since sharp variations in effluent composition (i.e., peaks) are not taken into consideration.

Plant personnel are aware of the peaks superimposed on the baseline and suspect them of contributing to high costs and poor disinfection performance. However, in the absence of any means of continuously measuring effluent chlorine requirement, neither the occurrence of a peak, its magnitude, nor its duration can be determined. This precludes making appropriate alterations in chlorine application. Thus the plant cannot routinely achieve adequate disinfection in spite of an excessive application of chlorine.

At the Southeast plant, chlorine is applied at two locations to accomplish two purposes. Pre-chlorination is carried out upstream from the plant's headworks, the primary purpose being to control odors. Approximately half the total chlorine used is applied here (i.e., about 6000 lbs/day giving a mean concentration of about 40 mg/l Cl_2). The remainder is applied to the final effluent as it leaves the sedimentation basins (see Fig. 6). This post-chlorination is for the purpose of

disinfection, i.e., killing enteric organisms (coliform bacteria being the accepted indicator). The total application rate of chlorine at both locations is approximately 12,500 lbs/day which is equivalent to about 80 mg/l in an effluent flow of 19 MGD. This rate is typically adjusted during the day in order to keep pace with diurnal changes in the baseline chlorine requirement. This pattern is shown by the stepped line on Fig. 14.* The shaded area below the stepped line but above the chlorine requirement curve represents excess chlorine. The shaded area above the stepped line but below the peaks represents the deficiency in the present chlorination practice. During this time, sewage is discharged to the Bay without sufficient chlorine to achieve required disinfection. It is important to note that the amount of sewage so discharged is really rather small, but because it contains such high numbers of coliforms, its effect is quite significant. Chlorine, when applied properly, is a very effective disinfectant. It is commonly capable of kill ratios of 1:1000 or more. The practical significance of this is that, for every hour that the plant discharges unchlorinated waste, the number of viable coliforms which enters the Bay is equivalent to operating some 1000 hours under adequate disinfection. Therefore, the small amount of time the peaks exceed the stepped line on Fig. 14 is anything but small in terms of coliform numbers. It is these coliforms to which the Regional Water Quality Control Board finds objection. Note that once coliforms are free in the Bay, they are comparatively safe from subsequent kill by chlorine. This is because the effluent is diluted rapidly by receiving water. Even though the chlorine concentration of subsequent discharges may be high, the residual chlorine within the dilution zone would not be sufficient to kill coliforms there.

* It should be noted that Figures 13 and 14 have been identified as being "hypothetical." They are surely representative of the pattern exhibited by effluent in a typical day but were not developed on the basis of measured data for any given day. To develop such a plot would require the use of techniques and equipment, the cost of which would not be warranted under a study of this scope.

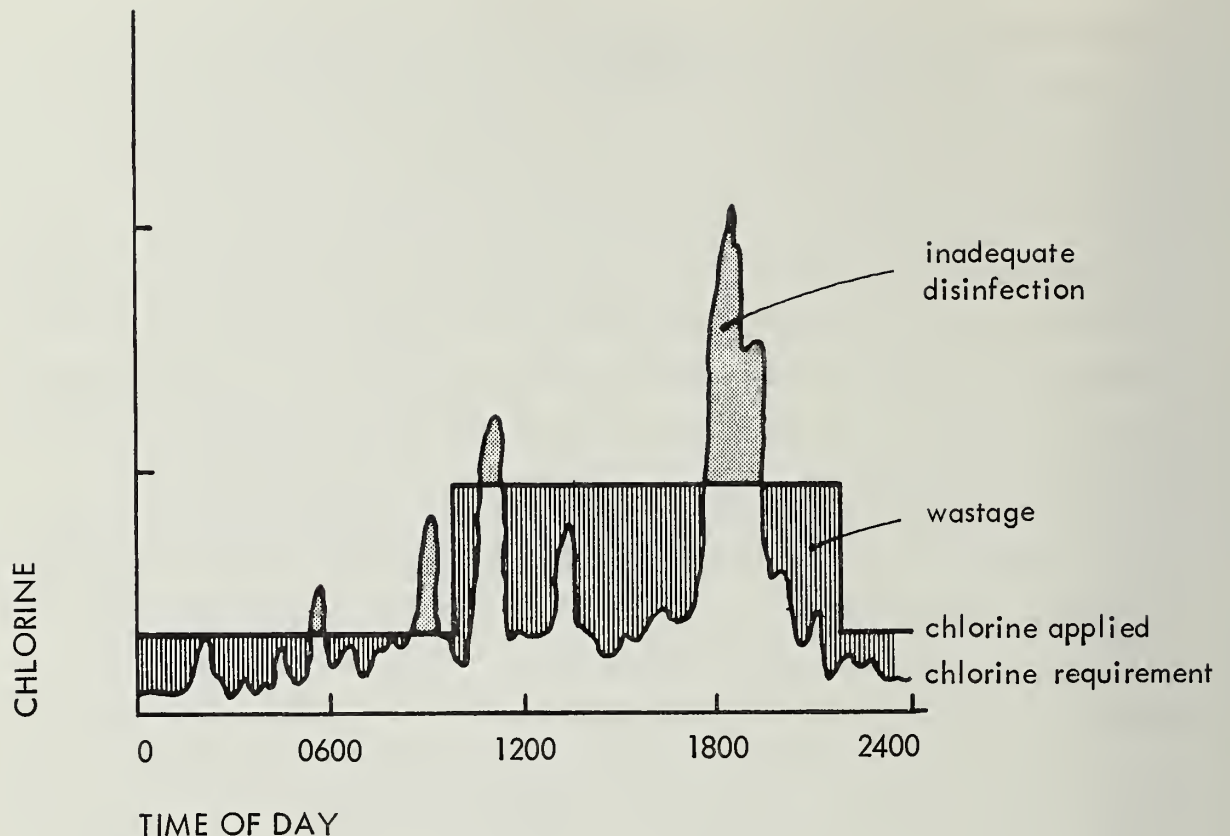


Fig. 14. Chlorination Practice Compared to Chlorine Requirement for Plant Effluent

Two tasks required in this contract were to:

- "conduct a series of bench-scale and in-plant experiments . . . to determine the most effective method or methods of chlorine application"
- "establish a modified chlorination program . . . (and) . . . determine the effectiveness of the modified chlorination schemes."

The former was accomplished using information developed in the in-plant data collection tasks described in Section 4. The comprehensive analysis provided much of the basis for predicting the results of alternative chlorination schemes. In this analysis, plant process streams were physically separated into numerous fractions and

individually analyzed for chlorine demand, COD, and solids. In-plant alternative methods considered included pre-chlorination, intermediate or staged chlorination, and post-chlorination. Two concepts of chlorinating wastes prior to delivery to the Southeast plant were also considered.

It was concluded that to maximize the key criterion (i.e., effective disinfection), all chlorine should be applied at the present point of post-chlorination. This will minimize the chlorine loss caused by side reactions with chlorine-demanding waste constituents, since the effluent has by far the lowest chlorine demand of any in-plant stream.

Note that this recommendation considers only the goal of disinfection, without regard for odor control. However, odor control is necessary and presently accounts for approximately half the total chlorine usage. Chlorination for odor control is currently applied as pre-chlorination just upstream from the plant headworks (Fig. 6). Pre-chlorination is relatively ineffective in reducing the coliforms discharged in the plant effluent, however. This is true for several reasons:

- Chlorine applied to raw sewage enters into many side reactions (as mentioned earlier), thereby leaving relatively little residual available to kill coliforms.
- The Southeast plant is operated such that an extremely large amount of chlorine demand, in the form of supernatants from the sludge thickening and elutriation processes, is added to the influent shortly after pre-chlorination. This serves to negate any chlorine residual which might have existed following pre-chlorination.
- The above supernatants also contain large numbers of coliforms. The fact that the mixture of influent and supernatants contains little or no chlorine residual means that such coliforms continue through the plant virtually unaffected.

Figure 12 depicts these relationships quantitatively. Influent (P-1) chlorine demand averages about 5000 lbs/day, the pre-chlorination rate

averages 6000 to 7000 lbs/day, and the combined supernatants average about 4000 lbs/day. Therefore, the mixing of influent and supernatants can easily use up all of the chlorine applied upstream. Since pre-chlorination is a major cost item and is not really effective in controlling effluent coliforms, it is recommended that other means of odor control be investigated.

Application of chlorine at a point (or points) between pre- and post-chlorination is not recommended. Chlorine should be applied only where disinfection is desired, i.e., the effluent.

Two concepts of chlorinating wastes prior to delivery to the Southeast plant were considered but ultimately rejected. One involved the chlorination of North Point sludge prior to transfer. The chlorine demand of this sludge is much too high to make this economically feasible (it is approximately 900 mg/l). Most of the coliforms in this sludge are probably physically removed in the Southeast plant; the remainder can be killed most effectively by post-chlorinating the comparatively weak plant effluent. The second concept involved chlorinating each of the major sewer mains prior to their entrance to the industrialized areas of the district. Sewage of residential origin has high coliform concentrations but relatively low chlorine demand. If this sewage were disinfected prior to the addition of industrial wastes, which tend to have high chlorine demands but low coliforms, the number of viable coliforms reaching the plant would be greatly reduced. However, the number of coliforms does not determine the amount of chlorine required at the point of post-chlorination. The amount required depends upon the chemical properties of the effluent, which this system would not really alter. The fact that the system would also require numerous chlorinators to be located throughout the district, in addition to chlorination facilities at the plant, further emphasizes its infeasibility.

Recommendations for improving the chlorination system's performance involve the installation of a dosage control system which would apportion

the rate of chlorine to effluent properties and flow. The conceptual design of such a system was presented in Section 4. The previously stated contractual objective of demonstrating the "effectiveness of the modified chlorination scheme" is not feasible and is indeed "subject to the physical limitations of the Water Pollution Control Plant." On the basis of all in-plant measurements and analyses, it is believed that the proposed modifications can save 30 to 60% of the chlorine presently applied, depending upon whether pre-chlorination is maintained as the means of odor control.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The aforementioned research program led to four principal conclusions:

- The present chlorination practice does not adequately disinfect all of the effluent discharged to San Francisco Bay
- The amount of chlorine applied in a typical day is greater than the amount actually required to achieve adequate disinfection of a day's sewage flow
- The degree of mixing and contact time (chlorine with effluent) are both adequate
- The cause of the chlorination system's ineffectiveness is that effluent chlorine demand varies significantly in short-term peaks which frequently exceed the rather uniform chlorine application rate. During such peaks, effluent is discharged to the Bay without benefit of adequate disinfection; hence the observation of coliform bacteria in Bay samples.

These conclusions are described in greater detail below.

RECOMMENDATIONS

The recommended solution to the disinfection problems at the Southeast plant is to provide a means for monitoring effluent chlorine requirement on a continuous basis and automatically apportioning the application rate in response to this and to flow rate. Such a system would allow the application rate to closely follow the fluctuating requirement curve; the advantages being a reduction in chlorine wastage and a marked improvement in disinfection effectiveness. A system which would accomplish such control has been designed conceptually and is described in the following paragraphs.

The system recommended here is of the "feed-forward" type. That is, data is collected (using flow meters and automatic analysis equipment) which allows the system to predict the proper amount of chlorine to be applied at a point forward of (i.e., downstream from) the point of sample collection. The alternative would be a "feedback" type which is a control "after the fact." The dynamic changes in effluent chlorine demand would limit a feedback system's ability to respond properly at the Southeast plant.

The recommended control system is shown in Fig. 15. Settled sewage samples are collected continuously from a point approximately 10 minutes upstream from the sedimentation basin discharge weirs. These samples are delivered to three separate chambers where they are mixed with chlorine water. Pumps A, B, and C discharge at three different, but uniform, flow rates ($A : B : C :: 1 : 10 : 100$). Chlorine water is delivered at the same rate to all three mixing chambers. The chambers are sized such that all give a contact time of 10 minutes. Following this contact, samples flow to the automatic chlorine residual analyzer, which transmits its data to the logic center. The logic center receives and processes three types of information:

- Data on residual chlorine concentration
- The position of the selector valve (this tells the logic center which mixing chamber was analyzed)
- Data on effluent flow rate.

On the basis of this information, the logic center decides between one of two actions:

- If the chamber just analyzed contains a sample having a chlorine residual within the analyzer's range, the logic center signals an automatic valve positioner to adjust the chlorine feed rate as needed to maintain the residual within a prescribed range
- If the chamber just analyzed contains a sample having negligible or grossly excessive chlorine residual, the logic center signals the selector valve to deliver another sample which is within the analyzer's range. This new sample is then analyzed and the results used to apportion chlorine.

Note that the system actually performs the same functions as a lab analyst, but does them on an ongoing basis and provides feed control directly. The purpose of sampling 10 minutes upstream from the point of discharge is, of course, to assure that the sewage flowing past the post-chlorination diffuser is the same as the sewage just analyzed (in a "feedback" system, changes can only be made after it is too late to effect remedy).

While the recommended system has been designed only at the conceptual level and requires further study regarding the selection and sizing of components, its installed cost would probably be on the order of \$15,000 to \$20,000 (assuming that those components already available at the Southeast plant can be used).

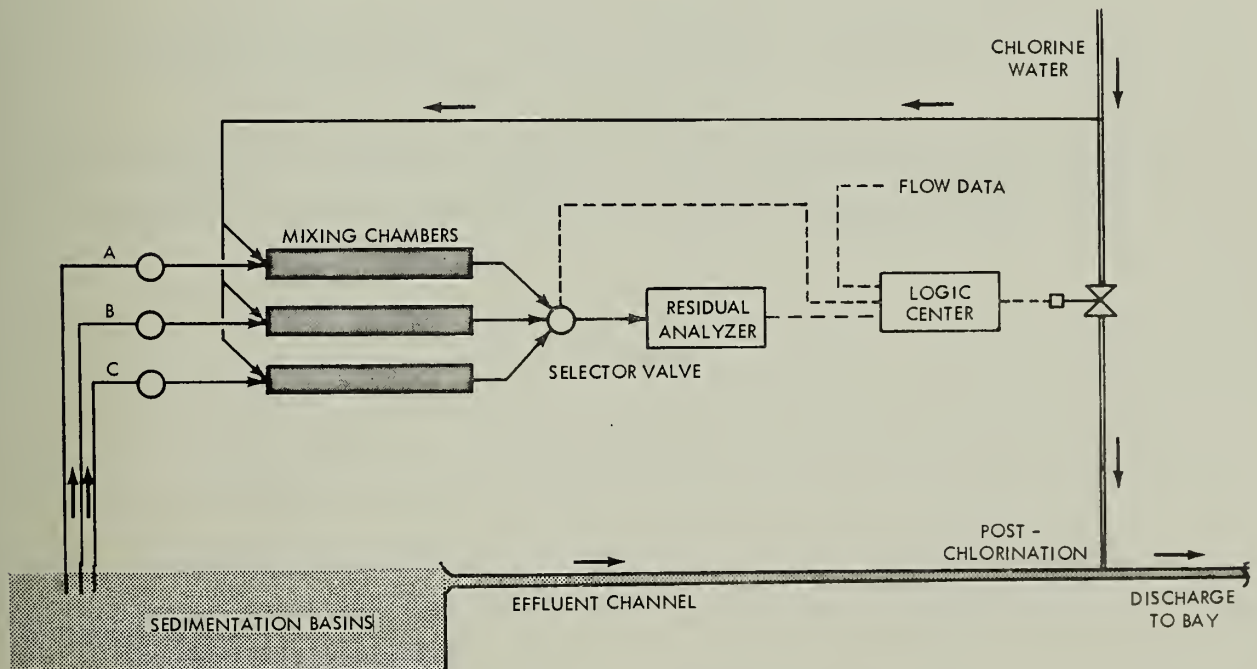


Fig. 15. Schematic Representation of Recommended Chlorine Residual Monitoring and Dosing Apparatus

Section 7
REFERENCES

1. Directory of Manufacturers, Greater San Francisco Chamber of Commerce, 1967.
2. Standard Methods for the Examination of Water and Wastewater (12th Edition) American Public Health Association, Inc., New York, 1965.
3. Nusbaum, I. and Meyerson, L. A., "Determination of Chlorine Demands and Chlorine Residuals in Sewage", Sewage and Industrial Wastes, 23(8) 968-76, 1951.
4. Water Quality Criteria (2nd Edition), McKee and Wolf, California State Water Quality Control Board, 1963.
5. Water Quality Criteria - Report to the National Technical Advisory Committee, Federal Water Pollution Control Administration, 1968.

Appendix A

DESIGN OF FUTURE TOXIC WASTE STUDY

The toxic waste study described in this appendix has not been performed to date. Rather, it is a proposed study, the design of which was included as a part of the work statement of the present contract.

San Francisco, like most metropolitan centers, is faced with the problem of treated sewage effluents which contain materials which are detrimental to biological systems in receiving waters. This situation is of concern to the City Public Works staff, the Regional Water Quality Control Board, and various commercial interests, as well as to the public.

Problems regarding toxic waste constituents are particularly difficult to solve for several reasons:

- Although relatively easy to treat as concentrated wastes, they become virtually untreatable when diluted in sewage flows
- Such materials are generally found in the soluble state and therefore pass through primary treatment plants virtually unaffected
- They generally exhibit considerable stability over extended time periods and are generally in unreactive chemical states so that they tend not to be diminished by biological degradation or by reaction with other waste constituents
- They are detrimental to biological systems even in minute concentrations
- Many become concentrated by several orders of magnitude through transfers in complex biological food chains
- The relationship between toxicants and their effects in receiving waters is only poorly understood at the present state-of-the-art.

These factors are of practical significance to the City of San Francisco because treated wastes are presently being discharged even though they contain unacceptably high concentrations of toxicants. The Regional Water Quality Control Board's requirements are expressed in terms of the waste's effects on organisms in bioassay tests. Although this approach is particularly valuable to a regulatory agency concerned with controlling the effects of a heterogeneous waste discharge into a relatively unpolluted receiving water, it is of limited value in determining the toxicity of a specific industrial waste which becomes mixed with total sewer flow. For such purposes, it is much more convenient to identify and evaluate any industry on the basis of the specific waste constituents discharged.

The study described in the following paragraphs is designed to provide the City with a basis for identifying and dealing with individual discharges in order to meet the requirements imposed by the Regional Board with a minimum of effort and a reasonable degree of equity to the dischargers.

The proposed study would consist of the following major tasks:

- A literature review
- A field sampling and analysis program
- An identification of major toxicant contributors
- A series of separate studies of selected industrial establishments.

The literature review would be performed to find information regarding the effects of toxic materials on biological systems. Particular emphasis would be placed upon recently developed information concerning the singular and synergistic effects of common heavy metals, organic pesticides, and related materials on marine organisms. Past and present studies would be reviewed to obtain information relevant to conditions in San Francisco Bay.

The field sampling and analysis program would draw upon four sources of information for direction:

- The industry survey described in Section 2 of this report
- The field data obtained under the toxic materials screening study described in Section 3
- City records which are relevant to toxic waste discharges
- Information developed as the proposed program progresses.

Determination of sampling sites would depend upon information gathered from these sources.

Since toxic materials are relatively stable, composite samples could be collected over a long period of time. This would improve data reliability and reduce overall costs.

Analysis of samples would involve preliminary qualitative screening to confirm the presence of important toxicants prior to quantitative analysis. The screening process would involve the use of recently developed ring-oven microanalysis techniques for heavy metals and probably carbon-chloroform extracts for organic pesticides. Subsequent quantitative tests would then be performed by local analytical laboratories; this proved quite satisfactory in the present study. A series of bioassay tests would contribute quantitative tests for toxicants. The purpose of the assays would be to develop as much information as possible regarding specific compounds and their practical effects on marine life. A unique approach to conducting bioassays, based upon a modification of the standard 96-hour survival test, has been conceptually developed by URS staff. This approach allows the synergistic effect of combinations of toxicants to be considered.

The third major task of the study would be to isolate and identify major dischargers of toxicants based upon data collected by the field sampling program. Subsequent effort would be to describe the wastes of selected major dischargers sufficiently to provide the City with a basis

for deciding what control measures are most appropriate. A study for each establishment (or perhaps selected groups of establishments) would include the following tasks:

- Contacts with industry representatives
- Examination of on-premises operations
- Collection and analysis of discharge samples
- Exploration of possible solutions (only at the conceptual level)
- Submission of conclusions and recommendations to the City Public Works staff.

The purpose for conducting studies of individual establishments is to provide the City with a basis for deciding on further action to control toxicants. Obviously, it is important for the City to know the amount and nature of wastes discharged to the sewer system. An important output of the studies on selected industries would be a delineation of the range of alternative controls available to those industries to reduce toxic discharges (i.e., changing raw material inputs, processes or operations; changing "housekeeping practices"; adopting pre-treatment or product recovery; or disposal by a contractor).

The overall toxic waste study described above would require the coordinated efforts of personnel skilled in the following disciplines: sanitary engineering, biology, chemistry, industrial engineering, and industrial economics. The study would extend over a period of 6 to 8 months and would cost on the order of \$60,000 plus approximately \$7,000 to \$10,000 for constituent analyses and bioassays.

DETERMINATION OF CHLORINATION SYSTEM COSTS

The cost of chlorination at the Southeast plant has the following components:

- The cost of purchasing chlorine gas (the average daily use is about 12,500 lb or about \$350)
- The cost of labor for operation and maintenance (estimated at about \$30 per day average)
- The cost of amortizing past capital expenditures for chlorination equipment and appurtenances (estimated at about \$40 per day).

The amortization cost was derived on the basis of the following assumptions:

- The purchase price of the chlorination equipment presently in use amounts to about \$65,000, which is equivalent to an annual cost of \$8,830 per year or about \$24 per day (assuming a rate of 6% over 10 years)
- The cost of appurtenances and installation of chlorine facilities is estimated at an additional \$80,000 which is equivalent to about \$16 per day (assuming 6% over 30 years).

Total chlorination costs are therefore about \$420 per day or 3.36 cents per pound of chlorine demand satisfied.

Appendix C
EXHIBITS FROM INDUSTRY SURVEY

The following map shows the locations of industries that could possibly contribute pollutants to the Southeast District sewage load. It is numerically keyed to an accompanying industry list. Both the list and the map are also numerically keyed to a reference card file. Because of its considerable bulk the file has been submitted to the city separately.

The reference card file contains information obtained from an industrial questionnaire. An example of the questionnaire as submitted to industries in the Southeast District is also included in this appendix.

INDUSTRIES SCREENED IN URS



INDUSTRIES SCREENED IN URS
CHLORINE DEMAND / TOXIC
WASTE STUDY



1. FMC - Link Belt Div.
400 Paul Ave.
2. Planter's Peanuts
500 Paul Ave.
3. All West Container Co.
1720 Fitzgerald
4. Danacolors Inc.
1833 Egbert Ave.
5. Kraft Foods
2660 Newhall St.
6. Metten & Gebhardt Inc.
1775 Egbert Ave.
7. Lucky Breweries Inc.
2601 Newhall St.
8. National Biscuit Co.
2540 Newhall St.
9. Wells Die Casting Co.
1960 Carroll Ave.
10. Erickson Products Co.
see Wells, No. 9
11. H. Shenson Inc.
1955 Carroll Ave.
12. Armanino Farms
1970 Carroll Ave.
13. Simon Mattress Mfg. Co.
1777 Yosemite Ave.
14. Kinnear Mfg. Co. Calif.
1742 Yosemite Ave.
16. Kortick Mfg. Co.
5600 Third St.
17. Coca-Cola Co.
5800 Third St.
1500 Mission St.
18. Uniroyal
6025 Third St.
19. R. Torre & Co.
5835 Third St.
20. Swiss Amer. Saus. Co.
35 Williams St.
21. Dependable Furniture Mfg. Co.
45 Williams St.
22. Goss & Goss Inc.
1415 Van Dyke @ Jennings
23. Geo. Bensen & Sons
1350 Van Dyke Ave.
24. Jenson Mfg.
1337 Van Dyke Ave.
2101 Ingalls St.
25. Clarence T. Braun Co.
1207 Thomas Ave.
26. Bay Area Drum Co.
1212 Thomas Ave.
27. Quality Metal Finishes
1207 Shafter Ave.
28. Leggalett Tanning Co.
1099 Quesada Ave.
29. Pacific Fan & Blower Co.
1132 Quesada Ave.
30. K & H Mfg. Co., Inc.
1055 Underwood Ave.
31. Lead Products Shielding Co.
1070 Van Dyke Ave.
32. Uro-Tec Precision Machining
1500 Wallace Ave.
33. Tappy's Fine Sausage
1450 Wallace Ave.

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|---|---|
| 34. P. G. Molinari and Sons
1401 Yosemite Ave. | 52. National Lead Co.
Marine Drive @ Kansas St. |
| 35. Western Piping & Engr. Co., Inc.
1485 Yosemite Ave. | 53. Geo. A. Hormel & Co.
2121 Evans Ave. |
| 36. Seven-Up Bottling Co.
1590 Yosemite Ave. | 54. Pacific Inflatibles Co.
2045 Evans Ave. |
| 38. T & W Enameling Co.
1562 Bancroft Ave. | 55. James Meagher's & Sons
270 Napoleon St. |
| 39. Devencenzi Drayage
Keith St. @ Bancroft Ave. | 56. Hawley Forge Co.
2325 Jerrold Ave. |
| 40. Alta Asbestos Products Co.
1414 Donner Ave. | 57. AAA Brass Foundry Inc.
2275 Jerrold Ave. |
| 41. Peroxide & Specialties Co.
1400 Carroll Ave. | 58. Learner Co.
2200 Jerrold Ave. |
| 42. Clarkson Laboratories Inc.
2655 Ingalls St. | 59. Apparel City Cleaners
2230 Palou Ave. |
| 44. Ventana Aluminum Mfg. Co.
1425 Donner Ave. | 60. Cariani Sausage Co.
2424 Oakdale Ave. |
| 45. Stero Dishwashing Machine Mfg.
Co.
1350 Donner Ave. | 61. Domestic Cheese Co. Inc.
450 Toland St. |
| 46. United Brass Foundry
1300 Donner Ave. | 62. Parisian Bakeries Inc.
1995 Evans Ave. |
| 47. Bay Carbon Co. Inc.
1375 Fitzgerald Ave. | 63. C. E. Grosjean Rice Milling
1875 Marin St. |
| 48. Savon Wholesale Cleaners
1324 Fitzgerald Ave. | 64. S. F. Produce Terminal
Jerrold Ave. @ Rankin St. |
| 49. Soule' Steel Co.
1750 Army St. | 65. Treck Photographic Inc.
2136 Palou Ave. |
| 50. Oscar Presco & Son
1270 Missouri St. | 66. Jorgenson & Co.
15 Dorman St. |
| 51. American Smelting & Refining
Co.
1901 Army St. | 67. Chas. Bruning Co.
75 Industrial St. @ Palou Ave. |
| | 68. Square - D Co.
211 Industrial St. |

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| 69. Terminix of Northern Calif., Inc.
250 Industrial St. | 86. McKesson Chemical
241 Quint St. |
| 70. Bayshore Car Wash
550 Bayshore Blvd. | 87. New S. F. Fish & Bait Distributor
Inc.
1401 Davidson Ave. |
| 71. Bayshore Steam Cleaning
500 Bayshore Blvd. | 89. Washington Fish & Oyster Co. of
Calif.
2 Rankin St. |
| 72. Transport Tire Co.
185 Bayshore Blvd. | 90. ABC Auto Parts
1650 Davidson Ave. |
| 73. James Allan and Sons
1490 Fairfax Ave. | 91. Circosta Iron & Metal Co.
1801 Evans Ave. |
| 74. Ace Metals Co.
1429 Fairfax Ave. | 92. Pacific Vinyl
1650 Evans Ave. |
| 75. Western Plastics Co.
1530 Galvez Ave. | 93. Stow Mfg. Co.
1630 Evans Ave. |
| 76. Metals Heat Treating Co.
1209 Evans Ave. | 94. West Coast Salvage Co.
1625 Evans Ave. |
| 77. Anderson & Cristofani
Innes Ave. @ Griffith St. | 95. Keystone Heavy Plate Battery Co.
1695 Galvez Ave. |
| 79. Western California Products Co.
see Allan, No. 73 | 96. Henry Discount Laundry
1660 Hudson Ave. |
| 80. S. De Bella Barrel Co.
301 Mendell St. | 97. Syn-Mar Marble Mfgs.
1683 Jerrold Ave. |
| 81. Royal Tallow & Soap Co.
1260 Davidson Ave. | 98. Ocean Shore Iron Works Inc.
1660 Jerrold Ave. |
| 82. Pacific Rendering Co.
370 Burke Ave. | 99. Wm. Taaffe & Co., Inc.
1536 Evans Ave. |
| 83. Crest Car Wash
3433 Third St. | 100. Pacific Pavements Co., Ltd.
1275 Michigan St. |
| 84. Baker Commodities Inc.
Pier 92
Islais St. | 101. Feedstuffs Processing Co.
1200 Minnesota Ave. |
| 85. Port of S. F. Grain Terminal
Corp.
3301 Third St. | 102. Somerset Type Metal Co.
1220 Pennsylvania Ave. |

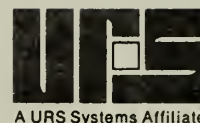
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| 103. M. J. Noble Co., Inc.
1250 Pennsylvania Ave. | 137. C. J. Figone & Sons
815 Tennessee St. |
| 104. New City Laundry
1260 Pennsylvania Ave. | 144. Crown Cork & Seal Co.
2650 Bayshore Blvd. |
| 105. Cargill Incorporated
1301 Army St. | 145. Schlage Lock Co.
2201 Bayshore Blvd. betw.
Sunnydale Ave. & Blanken Ave. |
| 106. Luchetti Choice Meats
1100 Army St. | 146. Southern Pacific Railroad
(Maintenance yard near
Bayshore Blvd.) |
| 107. Foster Poultry Farms
1565 Minnesota Ave. | 150. Fred Meyer (Modern Plating and
Polishing)
1499 Potrero Ave.
see No. 221 |
| 108. Peninsula Linen Exchange
1575 Indiana St. | 151. Knudsen Dairy Products - Borden
Division
1325 Potrero Ave. |
| 109. De Boom Paint Co. Inc.
1300 22nd St. @ Mississippi St. | 152. S. F. Municipal Railway
San Bruno Ave. @ 23rd St. |
| 110. American Can Co.
2345 Third St. | 153. National Lead Co.
2240 24th St.
see No. 52 |
| 111. Bethlehem Steel Corp.
20th St. & Illinois St. | 154. Pacific Gas & Electric Co.
22nd St. @ waterfront |
| 112. Armor Galvanizing Works
711 Indiana St. | 155. The Cookson Co.
700 Pennsylvania Ave. |
| 113. Geo. Abitsch Iron Works
701 Indiana St. | 156. F. Uri Co., Inc.
1209 Tennessee St. |
| 115. Triple A Machine Shop Inc.
Pier 64 China Basin | 157. A. M. Castle Steel
800 Indiana St. |
| 132. California Pest Control Co.
1000 Mariposa St. | 158. Acme Steam Cleaning Service
645 18th St. |
| 133. Doss Enameling Co.
601 Mariposa St. | 159. Phillips Petroleum
375 Illinois St. |
| 134. Montague Pipe & Steel Co.
1999 Third St. | 160. Goodyear Rubber Co.
2400 Third St. |
| 135. Protective Finishes
550 - 18th St. | |
| 136. Kohl & Madden Printing Ink
970 Tennessee St. | |

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| 161. Sun Valley Dairy
Nevada St. & Crescent Ave. | 186. Apex Machine & Foundry Co.
1355 Van Dyke Ave. |
| 162. Farmer's Market
100 Alemany Blvd. | 187. Evergood Sausage Co.
1389 Underwood Ave. |
| 163. Reliance Universal Inc.
210 Bayshore Blvd. | 188. Nieco Products Inc.
2690 Jennings St. (betw.
Carroll Ave. & Donner Ave.) |
| 164. Blue Ribbon Soap Co., Inc.
1601 Cortland Ave. | 189. Young Hides
1395 Evans Ave. |
| 165. Pico Battery Mfg. Co.
1525 Cortland Ave. | 190. Oppenheimer Casing Co.
1320 Evans Ave. @ Lane St. |
| 166. S. F. Municipal Railway
San Jose Ave. @ Geneva Ave.
see No. 152 | 191. Arden Farms
2065 Oakdale Ave. |
| 169. Pacific Poultry Co.
2414 San Bruno Ave. | 192. Norman Paint Co.
2003 Oakdale Ave. @ Rankin St. |
| 170. Tiger Car Wash
2605 Bayshore Blvd. | 193. Jack Horner Pie Co., Inc.
1990 Oakdale Ave. @ Rankin St. |
| 176. California Bucket Co.
1201 Shafter Ave. | 194. Rich Pie Shop
1980 Oakdale Ave. |
| 178. Sourdough Jack's Country
Kitchen
1095 Kansas St. | 195. McCoy Meat Co./Central Provision
Co.
1710 Oakdale Ave. @ Newhall St. |
| 180. Protasil Industries Inc.
86 Dorman Ave. | 196. Reefer-Galler Inc./San Francisco
Warehouse Co.
200 Napoleon St. |
| 181. Ocoma Foods Co.
1625 Carroll Ave. | 197. Magic Valley Packing Co.
see No. 73 (part of James Allan &
Sons) |
| 182. Magnus Chem.
2051 Third St. (betw.
18th St. & Mariposa St.) | 198. Universal Foods Corp.
725 Army St. |
| 184. New Modesto Poultry Co.
5150 Third St. (betw.
Thornton Ave. & Bayview St.) | 199. Robt. A. Johnson Co.
701 Army St. |
| 185. Jos. Levin & Sons
2225 Third St. (betw.
19th St. & 20th St.) | 200. Cooper & Sons Bucket Co.
1380 Fairfax Ave. |

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| 201. Philip A. Hunt Chemical Corp.
707 Army St. | 218. Comstock Termite & Pest Control
1228 - 20th Ave. |
| 202. Refinishers, Inc.
1220 Fairfax Ave. | 220. Super Soap Co.
1306 Phelps St. |
| 203. Morck Brushes/PPG Industries
1301 Potrero Ave. @ 25th St. | 221. Modern Plating & Polishing
(Fred Meyer)
1458 San Bruno Ave.
see No. 150 |
| 204. California Bag Co.
590 Minnesota St. | 222. Hunters Point Naval Shipyard |
| 205. Jackson Products Inc.
1485 Bayshore Blvd.
(Sales Mart) | 223. P. G. & E.
Hunters Point Power Plant
see No. 154 |
| 206. Amp King Battery Co.
10 Loomis St. | 224. ABC Pharmaceutical
2176 Palou Ave. |
| 207. Trojan Inc.
1125 Mariposa St. | 225. Domb Emma Inc.
2225 Palou Ave. |
| 209. Amerace - Esna Corp.
2196 Palou Ave. | |
| 210. Carmona Chemical Co.
1001 - 17th St. | |
| 211. Dunn Chemical Co.
770 Minnesota St. | |
| 212. Surtek Chemical Co./Stanley Sales
1455 Custer Ave. | |
| 213. P - C Western Chemical, Inc.
1246 - 18th St. @ Texas St. | |
| 214. Pac Hide & Leather Co.
1405 Minnesota St. | |
| 215. Pacific Coast Products
1050 - 26th St. | |
| 216. Economy Refining & Service Co.
782 Minnesota St. | |
| 217. Bix Furniture Stripping Service
141 Williams Ave. | |

URS RESEARCH COMPANY

155 Bovet Road, San Mateo, California 94402
(415) 574-5000 Cable: URSYST



April 14, 1970

Industries and Commercial
Enterprises in San Francisco

Gentlemen:

We are writing to ask for your cooperation in conducting a study of the industrial waste management requirements in the southeastern section of San Francisco. As you are surely well aware, the City and County of San Francisco has been experiencing some serious difficulties in providing adequate treatment of wastes at the Southeast Sewage Treatment Plant. URS Research Company has been retained to determine the amount and nature of waste materials discharged to the plant such that its operation can be modified to achieve adequate treatment at a reasonable cost to the taxpayers.

We feel confident that, given adequate and reliable information to describe the waste materials to be treated, an effective waste management system involving both industry participation and municipal participation can be developed and Regional Water Resources Control Board requirements met.

The enclosed questionnaire will help us to obtain some of the necessary information. We ask that you read the introductory remarks, the attached letter from the Director of Public Works, and complete all parts of the questionnaire to the best of your ability. Please return the completed questionnaire by no later than Friday, May 1, 1970, to:

Environmental Systems Division
URS Research Company
155 Bovet Road
San Mateo, California

Thank you for your cooperation.

Sincerely yours,

ENVIRONMENTAL SYSTEMS DIVISION

Franklin J. Agardy
Franklin J. Agardy, Ph.D.
Principal Sanitary Engineer

FJA:ms



DIRECTIONS FOR COMPLETING QUESTIONNAIRE

What we mean by "wastes"

The wastes that commercial/industrial activities typically discharge to the sewer result from the following:

- discarding raw materials and/or spent process solutions, slurries, sludges, and fine solids which are not suitable for further use
- discarding damaged or off-specification finished goods and materials which are not suitable for sale
- accidental spillage of the above materials
- preparation of raw materials
- cleanup of facilities, equipment, and work areas
- discharging spent cooling water
- use of sanitary facilities

Describing wastes

In some cases it is easy to describe the character of a waste directly in terms of its consistency and the types of materials it contains. In other cases it is easier to use the indirect approach of estimating what the waste should be like, on the basis of the raw materials purchased each month (generally, all purchased materials which are not shipped out with the final product end up in either the sewer or the garbage can). A review of your typical operations should give a clue as to what wastes you discharge.

Variations with time

The amount of waste discharged over a long period of time is fairly stable and depends upon the size and nature of your business. The short-term rate of discharge, however, will generally fluctuate considerably. One type of fairly repetitive fluctuation is due to cyclic changes in work schedule, raw materials availability, market seasonality, etc. These fluctuations are usually easy to describe. Another factor which can cause cyclic fluctuations in waste discharge rate is the schedule set by certain processing steps, particularly when batch-type production is used rather than continuous production. Such fluctuations may or may not correspond to regular work shifts (i.e., in a brewery, when a batch of beer is ready to leave the kettles, it must leave, and the equipment must be cleaned and wastes disposed of, whether this coincides with regular work shifts or not). These cyclic fluctuations in waste discharge can also occur as process chemicals or other expendables wear out or lose effectiveness.

Variations with time continued

There is a third kind of time variation which is best described as being erratic or unpredictable. These are caused by such things as accidents, an unexpected change in the raw materials or in the process, or some other operating difficulty. For these it is not possible to state just when the resultant waste discharges will occur. However, it is usually possible for an experienced operator or manager to estimate how often (say, the number of times a year) such events are likely to occur and the approximate amount and nature of waste likely to be involved.

QUESTIONNAIRE - PART "A"

Company name :

Address :

Telephone :

Brief description of the nature
of your business (i.e., the
goods, products, and/or services
you offer):

Name of person completing
this questionnaire :

Certification :

I hereby certify that the information given
in the attached questionnaire is complete
and accurate to the best of my knowlege :

signature

QUESTIONNAIRE - PART "B"

Waste description

Describe, in Table 1 below, the character of the wastes your operation typically discharges to the sewer. If you discharge several distinctly different types of wastes, describe each type separately.

Describe the waste's character in terms of its physical and chemical composition and properties, if you know them. If you do not, describe the waste in terms of the materials you expect it would contain, based on your knowledge of your operation and its use of input goods and materials.

Average discharge rate

Estimate the amount of waste you typically discharge on a monthly basis stated in terms of pounds/month or gallons/month, whichever is more appropriate, and report your estimate in Table 1. Try to exclude from your figures the amount of plain water you discharge we are interested only in the materials carried in the waste water, not the water itself. If you have several different wastes, report the flows for each.

TABLE 1

Chemical & physical
properties:

Constituent materials:

Average rate of
discharge, gal/month
or lbs/month:

QUESTIONNAIRE - PART "C"

Variations with time

Table 2 provides a simple means of indicating how your short-term waste discharge rate varies with time by comparing its maximums and minimums with the average rate. Use the table to describe the general nature of your discharge pattern by stating when your maximums and minimums occur and how high and low they are. We are asking only for approximate trends here.

TABLE 2a

Time(s) when maximum discharges occur :

Hours during day :	_____	Peak rate :	a	b	c	d
Days during week :	_____	Peak rate :	a	b	c	d
Months during year :	_____	Peak rate :	a	b	c	d

Code: a - peak is only slightly above average
 b - peak is about twice average rate
 c - peak is about four times average rate
 d - peak is more than four times average

TABLE 2b

Time(s) when minimum discharges occur :

Hours during day :	_____	Min. rate :	e	f	g	h
Days during week :	_____	Min. rate :	e	f	g	h
Months during year :	_____	Min. rate :	e	f	g	h

Code: e - low rate is only slightly below average
 f - low rate is about 1/2 average rate
 g - low rate is about 1/4 average rate
 h - low rate is virtually zero

QUESTIONNAIRE - PART "D"

Treatment and/or recovery facilities

Many industrial and commercial operations practice some sort of waste treatment or processing, either as a means of complying with sewer ordinances or as an attempt to recover salvageable materials from their wastes prior to discharge. If you practice any such treatment, describe your operation briefly in the space below.

Measurement and/or sampling facilities

As a part of the overall program being undertaken to provide adequate sewage treatment at the City's Southeast Plant, it will be necessary to sample and monitor the wastes discharged by selected commercial and industrial establishments. The selection of which establishments will be monitored will be made on the basis of the types of wastes we feel they are likely to be discharging not on the basis of ease of monitoring waste flows or collecting samples. However, for the purposes of planning and scheduling, it is important to know what facilities every establishment has which could allow convenient flow measurement and sample collection. Please describe your facilities in the space below.

Appendix D

RESULTS OF IN-PLANT ANALYSES

The following table contains the chlorine demand data for all analyses performed on in-plant samples.

Table D-1. TOTAL CHLORINE DEMAND DATA

SITE	LOCATION	DAY / TIME	Cl ₂ DEMAND (mg/l)
P-1	Plant Influent	Su/8:20	33.7
		Su/13:17	33.1
		Su/15:20	6.3
		Su/20:15	2.2
		M/00:30	2.1
		M/6:30	96
		Tu/8:30	24.9
		Tu/11:30	12.8
		Tu/15:55	9.8
		Tu/20:55	Neg.*
		Tu/22:30	3.6
		W/2:40	4.1
		W/4:15	5.1
		Tu/9:40	60.3
		W/9:15	124.0
		W/13:30	1.7*
P-2	Plant Effluent	Th/9:15	39.3
		F/10:10	2.0*
		Su/9:45	34.0
		Su/13:20	18.2
		Su/15:45	12.2
		Su/21:35	7.5
		M/1:30	6.4
		M/5:45	6.8
P-3	North Point Sludge at SE Plant		
		P-2 (cont.)	
		Tu/8:30	51.2
		Tu/14:15	6.1
		Tu/16:20	24.4
		W/2:00	10.8
		W/4:15	10.2
		W/6:15	10.6
		W/13:35	7.8*
		Th/13:45	26.2
		Su/10:00	91.2
		Su/11:30	111.5
		Su/14:10	85.8
		Su/17:00	122.3
		Su/23:30	186.0
		Tu/10:20	7.1
		Tu/12:30	138.5
		Tu/17:30	105.8
		Tu/21:00	98.0
		W/00:05	76.0
		W/2:45	91.0
		W/5:30	81.7
		W/14:30	213.3
		Th/14:00	259.3
		Th/9:30	242.0
		F/9:30	261.3

Table D-1. (Continued)

SITE	LOCATION	DAY / TIME	Cl ₂ DEMAND (mg/l)
P-4	Thickner Supernatant	Su/10:52	55.0
		Su/14:15	253.5
		Su/17:05	74.5
		Su/21:00	105.6
		M/4:30	132.5
		M/6:30	180.0
		Tu/10:25	114.2
		Tu/15:15	196.8
		Tu/17:55	191.9
		Tu/21:00	148.5
		W/00:05	106.8
		W/2:45	114.3
		W/6:15	126.3
		W/14:35	61.0
		Th/10:10	212.4
P-5	Filtrate	W/3:00	534.3
		Th/15:45	559.5
P-6	Elutriation Supernatant	Su/10:55	356.0
		Su/15:00	327.0
		Su/18:45	281.0
		Su/23:55	44.0
		M/3:45	551.0
		Tu/11:30	147.4
		Tu/15:45	91.5
		Tu/20:55	30.0
		Tu/23:40	73.7
		W/1:15	76.0
		W/3:45	72.0
		Th/10:15	83.0
		Su/8:30	12.1
		Su/12:30	27.1
P-7	North Point Sludge at North Point	Su/16:30	72.3
		Su/20:30	22.0
		M/4:30	47.8
		Tu/8:30	27.4
		Tu/12:30	39.3
		Tu/16:30	75.3
		Tu/20:30	148.7
		W/00:30	15.2
		W/4:30	27.9

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